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CONTENTS OF VOLUME L

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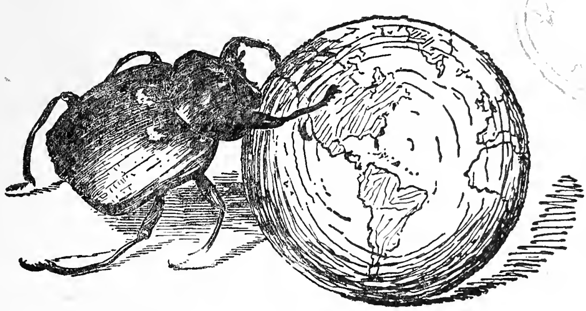

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THE BEHAVIOR OF CERTAIN INSECTS TO VARIOUS WAVE-LENGTHS OF LIGHT

By Harry B. Weiss, Frank A. Soraci, and E. E. McCoy, Jr.

This paper is the third of a series outlining the behavior of certain insects to light of various wave-lengths. The first two were published in the Journal of the New York Entomological Society, Vol. XLIX, p. 1–20; p. 149–159, 1941, and set forth the behavior under certain conditions, briefly an exposure for 15 minutes to eight wave-length bands of light of equal physical intensities from 3650 Å to 7400 Å. These lights were arranged in a circle around a central introduction point. The distance from the introduction point to the Corning monochromatic filter combinations was approximately one foot. Under the conditions, as described fully in the two previous papers, a more or less uniform type of behavior took place, in that for eighteen of the twenty-nine photopositive species tested, a wave-length band of 4700–5280 Ångstrom units attracted more individuals than any other band.

The present paper includes (1), a report of the results of additional tests in the circular apparatus described in the two previous papers, (2), an account of the behavior of various species in a new sector type of testing box, and (3), the results obtained in an additional piece of testing equipment which permitted more latitude in the variation of the physical intensities of the wave-lengths. The dates on which the various species were tested, relative humidity and temperature are found in Tables 3 and 4.

(1) BEHAVIOR OF ADDITIONAL LOTS OF INSECTS IN THE CIRCULAR TESTING APPARATUS

Before referring to Table 1, which is a detailed record of the behavior of additional lots of insects, it may be well to repeat that the insects in question were exposed for fifteen minutes to light of various wave-lengths, or colors, determined by the passage of light from forty-watt frosted Westinghouse Mazda lamps and a General Electric Mazda mercury lamp [Type A–H 4, 100 watts, which supplied the ultra-violet], through appropriate Corning monochromatic filter glass combinations. The physical intensities of the wave-lengths were equalized by regulating the distances between the source lamps and the filter combinations. The lamps were operated at 110 volts, alternating current. The method of

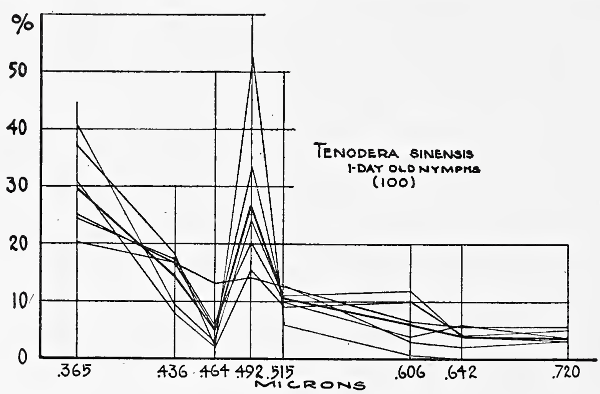

FIG. 1. Behavior of six different lots of 1-day-old nymphs of *Tenodera sinensis*. Heavy line indicates behavior of six lots combined.

handling the insects was identical to that described in the first paper. They were introduced approximately one foot from the filters. For convenience in making comparisons in relative intensities, the introductory intensity in this case will be designated as 100. In succeeding tests we were able, in our other equipment, to introduce the insects at distances of 1, 2, 3, 4, 5 and 6 feet from the filters. By adopting 100 as the introductory intensity when the insects were introduced at a distance of one foot from the filters, the relative introductory intensities at the other distances were approximately 25, 11, 6, 4 and 3.

In Table 1 the behavior of five species is set forth and it may be noted that in general their reactions to the eight light bands, to which they were exposed, were like the reactions previously recorded for other species. In other words, the light band extending from 4700–5280 Å (blue-blue-green) attracted the largest percentage of insects in each case except for *Macrocentrus ancylivorus* and for one-day-old nymphs of *Tenodera sinensis* in two cases, which were stimulated more or less equally at 3650–3663 Ångstrom units (ultra-violet) and by the 4700–5280 Å band. In the case of *Tenodera sinensis* (one-day-old nymphs) the largest percentage of these alternated between 3650–3663 and 4700–5280 Å. When the results of six tests, with new individuals each time, were totalled, 3650–3663 and 4700–5280 seem to be about equal in stimulating efficiency. This is shown in Figure 1 by the behavior curves of six different batches of one-day-old nymphs and by the heavy black line representing the combined responses for the six tests.

(2) BEHAVIOR OF VARIOUS SPECIES IN THE SECTOR TYPE EQUIPMENT

Because of certain inherent limitations of the circular apparatus, and the impossibility of having a completely dark chamber (for photonegative species), a new and larger equipment was built. This equipment (Figs. 3 and 4) was built essentially on a circular sector design. The filters and filter chambers were along the circular arc, the introduction chamber at the centre, and the radial sides included an angle of 72 degrees. Immediately behind the introduction chamber was a small rectangular dark chamber which permitted insects repelled by the light to find totally dark spaces. Thus after the insects were placed in the introduction chamber they could move either to the light or away from it to the black chamber. Ten wave-length bands were used, in their natural order, along the convex side of the equipment and when the insects emerged from the center of the introduction chamber, towards the light, they were exposed to all wave-lengths for a distance of at least 18 inches and within this area they had the opportunity of making a choice.

As in the circular apparatus forty-watt, frosted, Westinghouse Mazda lamps were used and the ultra-violet was supplied by a

TABLE 1

Name	No. tests	Total No. insects involved	Per cent of total in center	Per cent reacting	Distribution of those reacting to various wave-lengths*								Relative physical intensity at point of introduction
					3650 Å	4360 Å	4640 Å	4920 Å	5150 Å	6060 Å	6420 Å	7200 Å	
					Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	
Orthoptera													
Mantidæ													
Tenodera sinensis Sauss (1 day old nymphs)	1	224	40	60	31.0	8.1	2.2	52.0	6.0	0.7	0.0	0.0	100
Tenodera sinensis Sauss (1 day old nymphs)	1	301	27	73	41.1	9.6	3.2	24.2	13.2	3.2	2.3	3.2	100
Tenodera sinensis Sauss (1 day old nymphs)	1	257	14	86	24.4	17.6	6.0	20.0	11.3	11.7	4.0	5.0	100
Tenodera sinensis Sauss (1 day old nymphs)	1	352	32	68	20.5	16.8	5.6	33.4	10.0	4.1	5.9	3.7	100
Total of above plus two reported previously	...	......	......	......	29.5	14.6	5.0	26.5	10.6	6.1	4.0	3.7	100
Coleoptera													
Chrysomelidæ													
Leptinotarsa decemlineata Say	1	307	27	73	13.0	10.0	4.0	49.0	13.0	6.0	2.0	3.0	100
Coccinellidæ													
Megilla fuscilabris Muls.	3	326	32	68	12.7	11.7	9.0	30.0	15.0	8.0	7.3	6.3	100
Curculionidæ													
Myllocerus castaneus Roelofs	3	176	32	68	14.0	20.5	4.1	23.0	22.1	10.6	5.7	0.0	100
Hymenoptera													
Macrocentrus ancylivorus	1	101	30	70	40.0	9.0	1.0	38.0	10.0	1.0	1.0	0.0	100

* The Angstrom units represent the peak intensities of the bands.

General Electric Mazda mercury lamp (Type A–H 4, 100 watts). Corning filter glasses were used to isolate specific spectral bands. Each filter, or combination of filters, was, when in place, equally distant from the chamber into which the insects were introduced. The distance settings from the 40-watt lamps to the filter combinations, in order to equalize the physical intensities of the wave-lengths, were in all experiments the same as those shown in column 3, Table 2, Journal New York Entomological Society, Vol. XLIX, p. 10. The ten wave-length bands to which the insects were exposed were those shown in column 3, Table 1, Journal New York Entomological Society, Vol. XLIX, p. 9. It should be kept in mind that as the introduction chamber in this sector type of equipment was six feet away from the filter combinations, the physical intensities of the wave-lengths reaching the introduction chamber were only 1/36th of what they were when the testing was done in the circular apparatus where the insects were introduced one foot away from the filter combinations.

Thus, although the triangular apparatus enabled us to use ten wave-length bands in the spectrum and was equipped with a dark chamber, it forced us to introduce our specimens to energy that was only 1/36th as intense as that used formerly in the circular apparatus. This led to the construction of other equipment that shed more information upon insect behavior to light.

DESCRIPTION OF TESTING EQUIPMENT

The testing box, exclusive of the dark chamber and the light stand, was built of plyboard in the form of a sector having a radius from the center of the introduction chamber to the inside surface of the glass filters of 72 inches, and an outside chord of 86 inches. The arc of the sector was divided into 12 equal parts and, allowing for supports and insulating molding, we thus obtained 12 compartments six inches wide by three inches deep. The outer surface of each such compartment consisted of a plyboard slide with a $1\frac{3}{4}$-inch square opening in the lower left-hand corner over which the glass filters were placed and held firmly with thumb screws. Each of these compartments was divided in half with a plyboard strip, so that one-half of each compart-

ment was in total darkness during operation, while the other half was lighted. A plyboard slide formed the top of each compartment and two holes were bored in each top, then plugged with cotton. In using very active insects chloroform was dropped on these plugs and the insects killed at the end of a test. A slight space was allowed between the hinged tops of the central chamber and the tops of the outer compartments for the insertion of a metal slide at the completion of each trial. In this manner the insects were trapped in the outer compartments.

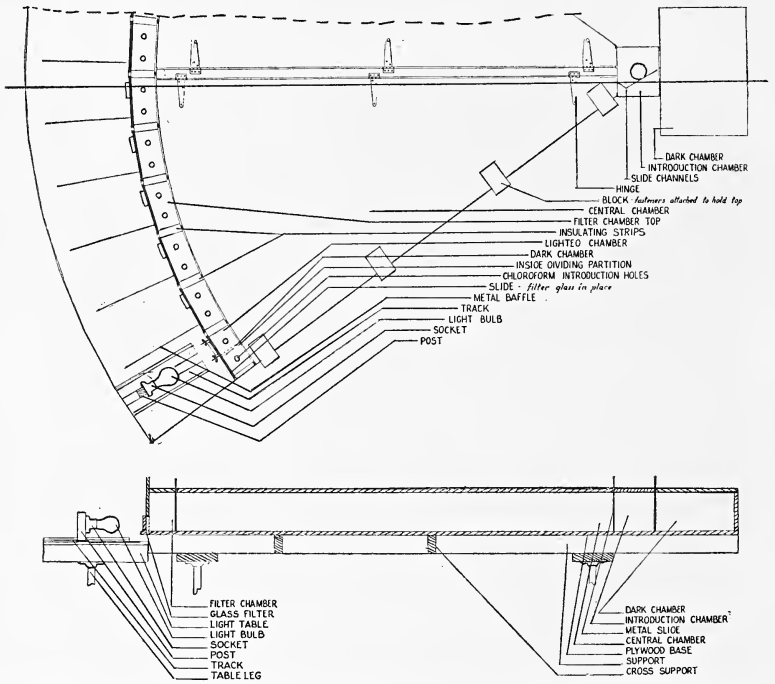

FIG. 2. (top) Top view of testing equipment showing principal parts and some details. (bottom) Vertical section through the centre of testing equipment.

A stand was constructed to hold the light bulbs. This stand was made of thin plyboard, well braced and mounted on casters so that it could be wheeled away from the end of the testing box to give easier access to the filter chambers. Tracks made of thin wooden strips were centered behind each filter so that when the

stand was in place the bulbs, mounted on wooden posts in the tracks, could be moved to the proper distances behind the filters. Metal baffles, painted black, were also fastened to the light stand to cut out interference from adjoining bulbs.

The two lids of the large central chamber were hinged along a central strip running the length of the chamber, so that at the end of a test these lids could be opened upward and braced, while the insects within were counted.

The introduction chamber, having an inside measurement of $6\frac{1}{4}$ inches by 6 inches, had a separate lid with a $2\frac{1}{2}$ inch hole bored

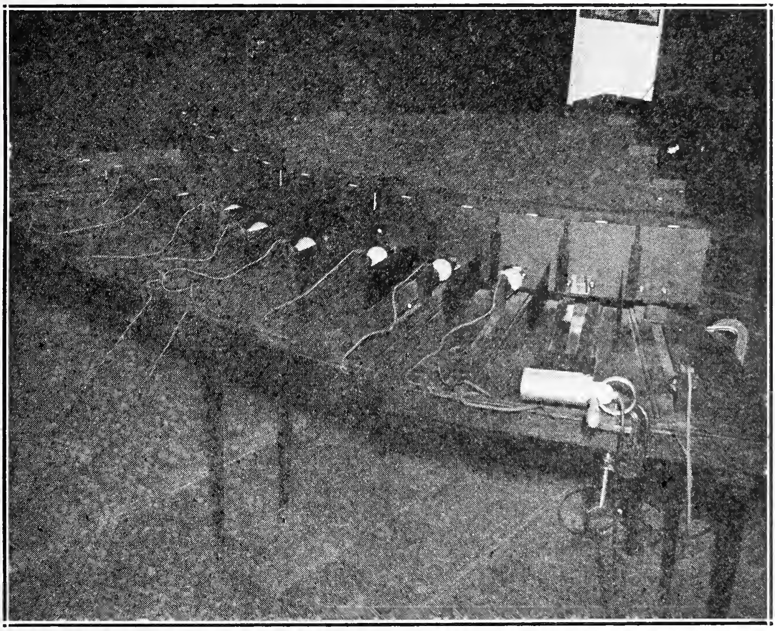

FIG. 3. View of testing equipment with lids closed.

centrally. It was the usual procedure to drop the insects from their containers into a funnel placed in this opening and thus to the floor of the introduction chamber. Channels were provided in front of the introduction chamber and behind it. These were covered during a test to prevent light leakage, but at the completion of a test metal slides were inserted thus trapping any remain-

ing insects, so that they might be counted. The dark or black chamber, which had an inside measurement of 18 inches by $12\frac{1}{4}$ inches, was added behind the introduction chamber and, of course, the insertion of the metal slide dividing the introduction chamber and the dark chamber served to trap in the dark chamber any

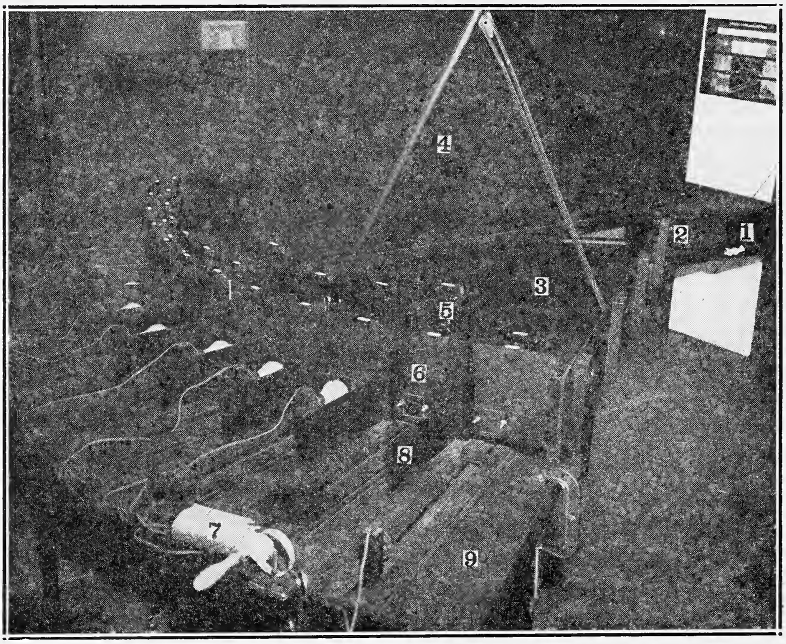

FIG. 4. View of testing equipment with one lid open. 1, dark chamber; 2, introduction chamber; 3, central chamber; 4, lid over one-half of top; 5, metal slide pulled up, this slide together with wooden slide 6 holding filters constitute two sides of filter chamber; Slide 5 also separates filter chamber from central chamber 3; 6, wooden slide holding filters, when removed exposes lighted and dark compartments of filter chamber so insects may be counted. At end of experiment metal slides like 5 are replaced, trapping the insects in the different filter chambers; 7, mercury lamp or source of ultra-violet; 8, metal baffle; 9, removable stand holding tracks and lamps.

insects that remained there at the completion of a test. The top of the dark chamber was removable so that the insect count could be obtained.

Molding was used on all joints in the box and all possible care was taken to insure light tightness of the whole apparatus. The

testing box was well braced with two by fours to prevent warping. The apparatus and all its parts were painted with a dull black paint (Figs. 3 and 4).

The insects were placed in the introduction chamber, after the lamps were on and all filter chambers were open. At the ends of the exposure periods the filter chambers were closed by metal slides and the central compartment, introduction chamber and dark chamber also were separated from each other in the same way. Counts were then made. So few insects went to the dark compartments alongside the lighted ones, that it was not thought necessary to report them separately. In the tables they are included with those listed as occurring in the dark chamber. The time of exposure was varied in accordance with the activity of the species and represents, in our judgment, the time needed for a reaction of one kind or another to take place.

RESULTS

In Table 2 there are presented the results of exposing twenty species of insects, mostly Coleopterous ones, to ten wave-length bands in the sector type equipment. By consulting the percentage distributions of the individuals reacting to the various wave-length bands, and by an examination of the behavior curves (Plates I and II), it may be noted at once that, with a few exceptions, the largest numbers of most of the species reacted positively to 3650–3663 Ångstrom units (ultra-violet). This took place when the intensity at the introduction point was 3, or 1/36th of the intensity at the introduction point in the circular apparatus.

Such species as *Leptinotarsa decemlineata, Chrysochus auratus, Scolytus multistriatus, Hylurgopinus rufipes* and *Tetraopes tetraophthalmus,* which were tested in both types of apparatus and which for the most part showed a peak response to 4700–5280 Ångstrom units (blue-blue-green) when they were introduced at a relative intensity of 100 (1 foot away from filters), gave a peak response to 3650 Ångstrom units (ultra-violet) when introduced at a relative intensity of 3 (6 feet away from filters).

Macrocentrus ancylivorus, when exposed to an introductory intensity of 100 exhibited peaks of equal magnitude at 3650–

TABLE 2

Name	No. tests	Total No. insects involved	Exposure minutes	Per cent in black chamber†	Per cent in introd. chamber	Per cent in center	Per cent reacting to wave lengths	Relative physical intensity at point of introduction
Coleoptera								
Lampyridæ								
Celetes basalis Lec.	3	262	25	8	22	42	28	3
Coccinellidæ								
Coccinella novemnotata Hbst.	2	145	20	11	17	25	47	3
Chrysomelidæ								
Disonycha quinquevittata Say	2	135	15	19	20	15	46	3
Blepharida rhois Forst.	3	407	30	4	19	23	54	3
Blepharida rhois Forst.	3	270	20	2	3	41	54	5
Chrysochus auratus (Fab.)	3	240	45	5	15	44	36	3
Lina lapponica Linn.	1	232	30	5	32	40	23	3
Lina lapponica Linn.	1	54	30	4	2	22	72	5
Galerucella xanthomelæna Schr.	1	219	20	2	53	11	34	3
Plagiodera versicolora Laich	2	101	25	6	5	40	49	3
Crioceris asparagi Linn.	3	502	40	2	18	58	22	3
Crioceris asparagi Linn.	1	76	30	0	3	23	74	3
Cerambycidæ								
Tetraopes tetraophthalmus Foer.	3	272	35	8	13	48	31	3
Tetraopes tetraophthalmus Foer.	3	405	40	2	0	73	25	5
Scolytidæ								
Hylurgopinus rufipes (Eich.)	1	272	30	3	47	25	25	3
Scolytus multistriatus Marsham	2	848	15	4	36	38	22	3
Scolytus multistriatus Marsham	1	287	30	7	25	29	39	3
Scarabæidæ								
Serica iricolor Say	3	382	20	17	9	36	38	3
Macrodactylus subspinosus Fab.	4	283	20	0	0	34	66	5
Macrodactylus subspinosus Fab.	3	254	15	2	14	15	69	3
Autoserica castanea Arrow (9:10 P.M.)	3	296	20	26	31	21	22	3

TABLE 2 (*Continued*)

Name	Distribution of those reacting to various wave-lengths‡									
	3650 Å	4360 Å	4640 Å	4920 Å	5150 Å	5460 Å	5750 Å	6060 Å	6420 Å	7200 Å
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Coleoptera										
Lampyridæ										
Celetes basalis Lec.	43	1	1	6	18	11	4	6	7	3
Coccinellidæ										
Coccinella novemnotata Hbst.	35	10	4	12	20	7	6	0	4	2
Chrysomelidæ										
Disonycha quinquevittata Say	11	16	18	32	13	6	0	0	2	2
Blepharida rhois Forst.	20	16	10	29	15	5	3	1	1	0
Blepharida rhois Forst.	16	26	16	20	6	8	3	1	3	1
Chrysochus auratus (Fab.)	47	11	10	6	8	6	3	3	5	1
Lina lapponica Linn.	62	7	2	21	6	0	0	0	2	0
Lina lapponica Linn.	64	2	8	8	8	5	0	5	0	0
Galerucella xanthomelæna Schr.	35	22	11	11	7	4	1	2	7	0
Plagiodera versicolora Laich	72	0	6	8	6	2	2	2	0	2
Crioceris asparagi Linn.	50	9	6	18	6	1	3	0	4	3
Crioceris asparagi Linn.	50	14	3	22	6	0	0	0	3	2
Cerambycidae										
Tetraopes tetraophthalmus Foer.	29	13	6	18	12	8	6	6	1	1
Tetraopes tetraophthalmus Foer.	51	9	4	9	10	2	4	5	5	2
Scolytidæ										
Hylurgopinus rufipes (Eich.)	52	3	3	5	9	5	10	3	10	0
Scolytus multistriatus Marsham	27	6	1	17	24	6	3	9	7	0
Scolytus multistriatus Marsham	34	4	4	14	18	13	0	7	6	0
Scarabæidæ										
Serica iricolor Say	50	10	2	7	12	7	4	3	3	2
Macrodactylus subspinosus Fab.	24	7	3	21	23	10	2	6	2	2
Macrodactylus subspinosus Fab.	39	7	6	27	9	6	1	3	2	0
Autoserica castanea Arrow (9:10 P.M.)	73	3	0	9	2	3	0	3	1	6

TABLE 2 (*Continued*)

Name	No. tests	Total No. insects involved	Exposure minutes	Per cent in black chamber†	Per cent in introd. chamber	Per cent in center	Per cent reacting to wave lengths	Relative physical intensity at point of introduction
Chrysomelidæ								
Leptinotarsa decemlineata Say	3	196	45	7	11	50	32	3
Leptinotarsa decemlineata Say	3	533	20	0	0	48	52	5
Leptinotarsa decemlineata Say	1	202	120	4	6	23	67	3
Leptinotarsa decemlineata Say*	3	817	60	8	16	46	30	3
Galerucella notata (Fab.)	3	546	30	5	19	19	57	3
Scarabæidæ								
Popillia japonica Newm.	3	287	25	3	6	40	51	3
Popillia japonica Newm.	3	302	30	2	0	53	45	5
Popillia japonica Newm.	3	358	45	2	14	32	52	3
Popillia japonica Newm.	3	437	20	6	5	27	62	3
Popillia japonica Newm. ♀	3	201	15	5	8	54	33	3
Popillia japonica Newm. ♂	3	192	15	2	6	43	49	3
Popillia japonica Newm.	1	276	20	3	5	25	67	3
Popillia japonica Newm.§	2	697	20	3	3	21	73	3
Hymenoptera								
Braconidæ								
Macrocentrus ancylivorus Roh.	1	47	30	6	11	15	68	3
Apidæ								
Apis mellifica L.	3	278	15	7	32	17	44	3
Apis mellifica L.	1	108	15	11	13	22	54	3
Hemiptera								
Coreidæ								
Leptocoris trivittatus Say	1	359	15	27	17	25	31	3

* Positions of 3650 Å and 4920 Å reversed.
† These percentages include the relatively small numbers that went to the black chambers between the light chambers.
‡ Ångstrom units represent peak intensities of bands.
§ Filters in disarray.

TABLE 2 (*Continued*)

Name	Distribution of those reacting to various wave-lengths‡									
	3650 Å	4360 Å	4640 Å	4920 Å	5150 Å	5460 Å	5750 Å	6060 Å	6420 Å	7200 Å
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Chrysomelidæ										
Leptinotarsa decemlineata Say	61	13	5	11	0	7	3	0	0	0
Leptinotarsa decemlineata Say	23	12	8	22	12	10	8	2	2	1
Leptinotarsa decemlineata Say	25	20	4	19	4	9	7	3	5	4
Leptinotarsa decemlineata Say*	31	8	9	27	12	3	5	2	3	0
Galerucella notata (Fab.)	14	10	6	33	20	7	6	3	1	0
Scarabæidæ										
Popillia japonica Newm.	22	14	10	26	22	3	2	1	0	0
Popillia japonica Newm.	6	2	8	35	30	13	2	2	2	0
Popillia japonica Newm.	10	11	7	26	26	14	2	2	1	1
Popillia japonica Newm.	27	9	8	18	20	7	4	4	3	0
Popillia japonica Newm. ♀	18	17	13	32	24	6	0	5	3	2
Popillia japonica Newm. ♂	15	19	11	23	19	8	1	2	1	1
Popillia japonica Newm.	14	15	14	25	18	7	2	2	2	1
Popillia japonica Newm.§	10	12	5	13	23	16	8	8	3	2
Hymenoptera										
Braconidæ										
Macrocentrus ancylivorus Roh.	44	6	6	29	6	6	0	0	3	0
Apidæ										
Apis mellifica L.	31	5	8	16	16	6	5	6	6	1
Apis mellifica L.	38	14	2	17	5	9	5	2	3	5
Hemiptera										
Coreidæ										
Leptocoris trivittatus Say	22	17	7	23	16	5	3	2	4	1

* Positions of 3650 Å and 4920 Å reversed.
† These percentages include the relatively small numbers that went to the black chambers between the light chambers.
‡ Ångstrom units represent peak intensities of bands.
§ Filters in disarray.

3663 Å and in 4700–5280 Å. When the relative introductory intensity was 3, the peak at 4700–5280 Å became secondary in comparison with 3650–3663 Å. The potato beetle, *Leptinotarsa decemlineata,* which was tested quite extensively, in new lots each time, exhibited the same type of behavior to a pronounced degree.

The Japanese beetle, *Popillia japonica,* which exhibited comparatively little interest in 3650–3663 Å, and which gave a peak response to 4700–5280 Å, when the introductory intensity was 100, did not follow the behavior of the other species so strongly when the introductory intensity was reduced to 3, but the responses to 3650–3663 Å went up slightly and the response to 4700–5280 Å dropped somewhat. However, the peak response continued in 4700–5280 Å or in that region.

These two types of responses, weak to 3650–3663 Å (ultra-violet) and strong to 4700–5280 Å when the introductory intensity was 100 (1 foot from filters); and strong to 3650–3663 Å and weak to 4700–5280 Å when the introductory intensity was 3 (6 feet from filters) indicated that the ultra-violet at an intensity of 100 was too intense when the insects were exposed suddenly to it, and also that the behavior pattern or the sensitivity of the insects to the spectrum could be varied by varying the intensities to which the insects were first exposed. In other words, it was suspected that the relative stimulating efficiency of various wave-lengths, of equal intensities, in that portion of the spectrum between 3650 Å and 7400 Å could be changed, within certain limits, by changing the distances between the source of the light and the point at which the insects were first exposed to it. This changes the introductory intensities while the physical intensities of the sources remain constant. In all cases the insects, at the completion of the tests, were subjected to equal light intensities regardless of the initial or introductory intensities.

Although the insects under consideration behaved as if they had wave-length discrimination or a perception of color, they also changed their behavior when the introductory intensities, to which they were exposed, were changed. It should be kept in mind that the changed intensities took place equally for all the wave-lengths to which the insects were exposed and up to a certain point the insects were free to make their choice among wave-lengths of equal physical intensities.

If different parts of the spectrum are preferred on account of the apparent luminosity of these parts then a wave-length of 3650 Å and a region in the neighborhood of from 4700–5280 Å would appear to be the most luminous to most of the insects at the intensities used. Of course this is only an inference drawn from their behavior. By the same reasoning the relative indifference of our species to 3650–3663 Å (ultra-violet) at an intensity of 100 (1 foot from filters) may have been due to the fact that the introductory intensity at this wave-length was too great for them.

Because of the importance of intensity in influencing their behavior it should be noted here that of the total number of individuals exposed to an intensity of 100 (1 foot from filters) about 25 per cent remained in the centre of the apparatus and did not go to any filter chambers. When the introductory intensity was

TABLE 3

Name	Date tested	Relative humidity during test	Temperature °C. during test	
			At start	At end
		Per cent		
Tenodera sinensis Sauss				
One-day-old nymphs	Feb. 25, 1941	30	24	25.0
One-day-old nymphs	Feb. 26, 1941	26	24	25.5
One-day-old nymphs	Feb. 27, 1941	30	21	24.0
One-day-old nymphs	Mar. 1, 1941	32	23	24.0
Leptinotarsa decemlineata Say	May 28, 1941	52	27	27.0
Megilla fuscilabris Muls.	Feb. 28, 1941	30	23	25.0
Myllocerus castaneus Roelofs	April 4, 1941	34	24	25.0
Macrocentrus ancylivorus	Mar. 7, 1941	30	23	24.0

reduced to 3 (6 feet from filters) the percentage not going to any filter chambers increased to around 54 per cent. The factor of increased space permitting more freedom of movement may have some bearing on these percentages.

This factor and the importance of the introductory intensity in determining the behavior to wave-length made it necessary to build another piece of equipment that was flexible enough to permit changes in the introductory intensities.

(3) BEHAVIOR OF THE POTATO BEETLE AND THE JAPANESE BEETLE TO WAVE-LENGTHS OF DIFFERENT INTRODUCTORY INTENSITIES

This work was conducted in two wooden, light-tight runways emanating at right angles to each other from an introduction chamber about 8.5 inches square. These runways were made in 1 foot sections that could be fastened together. Distal sections were equipped with sub-chambers, for the filters, and in which the insects could be trapped. By this means, it was possible to test the insects at distances of from 1 to 6 feet away from the light chamber, and consequently at different intensities (Fig. 6).

Because 3650–3663 Å and 4700–5280 Å were the wave-lengths to which the various species responded in the largest numbers, it was decided to operate these two in competition with each other at various intensities, *i.e.,* by introducing the insects at various distances from the sources of the wave-lengths. The results of these tests are shown in Tables 5 and 6. For example, using potato beetles, when the intensity of each of the competing wave-lengths was 100, 40 per cent of the reacting beetles went to ultra-violet and 60 per cent went to blue-blue-green. When the intensity of both was reduced to 25, 54 per cent went to ultra-violet and 46 per cent to blue-blue-green. When the intensities were further reduced the same type of progressive results continued. When the intensity reached 3, 80 per cent of the reacting beetles went to ultra-violet and 20 per cent to blue-blue-green.

The behavior of the Japanese beetle as shown in Table 6 followed the same trend when tested under similar conditions but the differences between the responses to the two wave-lengths at varying intensities were not so great as those for the potato beetle. Apparently with only two wave-length bands to choose from the Japanese beetle did not at different introductory intensities differentiate between them as sharply as did the potato beetle.

In our tests with the Japanese beetle, and with other photo-positive insects as well, where the physical intensities of the wave-lengths were equalized, either at 100, or 3, or some other figure, in nearly all cases that portion of the spectrum from about 5300 Å to 7400 Å had comparatively little attractive value. However, this was true only when that part of the spectrum was competing with the blue end at equal intensities.

TABLE 4

Name	Date tested	Relative humidity during test	Temperature °C. during test	
			At start	At end
		Per cent		
Celetes basalis Lec.	July 11, 1941	60	28.0	28.1
Coccinella novemnotata Hbst.	June 18, 1941	64	27.0	27.2
Disonycha quinquevittata Say	Aug. 4, 1941	40	29.0	29.5
Blepharida rhois Forst.	July 17, 1941	80	27.5	27.6
Blepharida rhois Forst.	July 18, 1941	73	27.0	27.0
Chrysochus auratus (Fab.)	June 26, 1941	50	27.0	27.0
Lina lapponica Linn.	June 7, 1941	55	25.0	25.1
Lina lapponica Linn.	June 23, 1941	62	29.0	29.0
Galerucella xanthomelaena Schr.	May 2, 1941	28	24.5	25.0
Plagiodera versicolora Laich.	May 12, 1941	41	24.5	25.0
Crioceris asparagi Linn.	May 9, 1941	45	26.0	26.0
Crioceris asparagi Linn.	May 15, 1941	45	26.0	26.0
Tetraopes tetraophthalmus Foer.	June 19, 1941	64	27.0	27.8
Tetraopes tetraophthalmus Foer.	June 18, 1941	60	27.0	27.0
Hylurgopinus rufipes (Eich.)	July 30, 1941	90	28.0	28.0
Scolytus multistriatus Marsh.	June 6, 1941	45	24.2	25.0
Scolytus multistriatus Marsh.	July 30, 1941	90	27.0	27.5
Serica iricolor Say	May 19, 1941	40	25.2	26.0
Macrodactylus subspinosus Fab.	June 9, 1941	38	26.0	26.0
Macrodactylus subspinosus Fab.	May 29, 1941	47	31.0	32.0
Autoserica castanea Arrow	July 11, 1941	62	29.5	29.5
Leptinotarsa decemlineata Say	May 21, 1941	52	26.2	26.4
Leptinotarsa decemlineata Say	May 28, 1941	62	28.0	29.0
Leptinotarsa decemlineata Say	June 10, 1941	25	26.0	27.0
Leptinotarsa decemlineata Say	June 3, 1941	52	26.1	26.5
Galerucella notata (Fab.)	Sept. 12, 1941	35	27.0	27.0
Popillia japonica Newm.	June 12, 1941	86	25.5	25.5
Popillia japonica Newm.	June 16, 1941	55	26.0	26.2
Popillia japonica Newm.	June 17, 1941	55	26.0	26.5
Popillia japonica Newm.	July 31, 1941	70	29.0	29.5
Popillia japonica Newm.	July 31, 1941	70	29.0	29.5
Popillia japonica Newm.	July 31, 1941	70	29.0	29.5
Popillia japonica Newm.	Aug. 14, 1941	40	29.0	29.0
Popillia japonica Newm.	Aug. 15, 1941	64	26.0	26.0
Macrocentrus ancylivorus	April 23, 1941	38	25.0	25.5
Apis mellifica L.	April 30, 1941	29	24.9	25.0
Apis mellifica L.	June 23, 1941	62	29.0	29.0
Leptocoris trivittatus Say	Oct. 2, 1941	42	26.0	26.0

Table 7 sets forth the results obtained with the Japanese beetle when ultra-violet and blue-blue-green at low introductory intensities competed with other colors in the red end of the spectrum at comparatively high introductory intensities. These tests were made in the apparatus last described, the runways being at right angles to each other. For example infra-red (6620–7400 Å), which attracted practically nothing in former tests where the intensities were equalized, attracted 10 per cent of the beetles when used at an intensity of 100 in competition with ultra-violet (3650–3663 Å) at an intensity of 3, which attracted 90 per cent.

TABLE 5

BEHAVIOR OF THE POTATOE BEETLE, *Leptinotarsa decemlineata,* TO ULTRA-VIOLET, AND BLUE-BLUE-GREEN LIGHTS IN COMPETITION AT VARYING INTRODUCTORY INTENSITIES

No. tests	No. insects involved	Per cent not reacting	Per cent reacting	Exposure	Per cent reacting to 3650–3663 Å (Ultra-violet)	Per cent reacting to 4700–5280 Å (Blue-blue-green)	Relative physical intensity of each wave-length band
				Minutes			
3	297	26	74	15	40	60	100
3	386	19	81	15	54	46	25
4	428	39	61	45	62	38	11
1	159	11	89	20	60	40	6
1	159	3	97	20	71	29	4
1	144	13	87	30	80	20	3
1	115	30	70	30	50	50	100
1	103	18	82	15	70	30	11
1	121	33	67	15	79	21	3
1	95	26	74	15	57	43	100
1	117	26	74	15	65	35	11
1	138	30	70	30	78	22	3

Orange-red (6120–6860 Å), another unattractive wave-length at equal intensities, when used at an intensity of 100 in competition with ultra-violet (3650–3663 Å) at 3 attracted 49 per cent of the insects. This type of behavior held true for the colors yellow-orange (5900–6420 Å), yellow-yellow-green (5550–6070 Å) and yellow-green (5300–5760 Å) when used in competition with ultra-violet (3650–3663 Å) under the same conditions.

The same behavior took place when blue-blue-green (4700–5280 Å) instead of ultra-violet was used in competition with the colors previously used. The intensity of the blue-blue-green was 3 and that of the other colors was 100. The results of these tests are also shown on Table 7.

Infra-red was not very attractive even at the greatly increased intensity and most of the beetles preferred to travel 6 feet to either ultra-violet or blue-blue-green, when the introduction intensity was 3, rather than 1 foot to the infra-red when the introduction intensity was 100. Another seemingly unattractive wave-length band, blue (4420–5000 Å), indicated by the constant dip in the behavior curves was also found to be attractive when the insects were introduced to it at a greatly increased intensity.

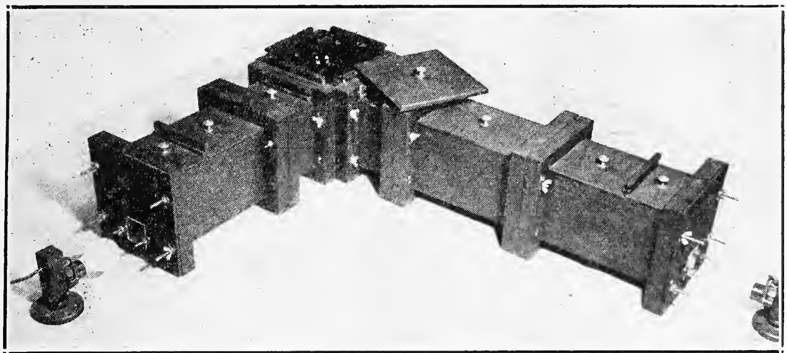

FIG. 5. Two-way apparatus, showing introduction chamber and several sections.

This behavior indicates that, within certain limits, relatively unattractive parts of the spectrum can be made attractive by increasing their intensities.

In order to find out what would happen if the insects were given a smaller choice of wave-length bands and if this choice were successively narrowed by eliminating one band after each trial, one half of the sector type of apparatus was used and the insects were exposed three feet away from the filters or at an introductory intensity of 11.

The results of these tests are outlined in Tables 8 to 11, the potato beetle and the Japanese beetle being utilized because of

their availability. As will be noted in Table 8, potato beetles were exposed to five bands extending from 3650 to 5660 Å for 30 minutes, and the reacting beetles went, in almost equal numbers, to every band except blue and blue-green. At the end of the next test which involved four bands, the blue-green having been dropped, the beetles again went in almost equal numbers to everything except blue. In the third test, with three bands to choose from the response was equal to ultra-violet and violet-blue, and low to blue. In the fourth test, involving two favorable colors, 62 per cent went to violet-blue. In the fifth test, the insects had no choice. It should be noted that throughout the tests the numbers reacting held up fairly uniformly.

TABLE 6

BEHAVIOR OF THE JAPANESE BEETLE, *Popillia japonica*, TO ULTRA-VIOLET AND BLUE-BLUE-GREEN LIGHTS IN COMPETITION AT VARYING INTRODUCTION INTENSITIES

No. tests	No. insects involved	Per cent not reacting	Per cent reacting	Exposure	Per cent reacting to 3650–3663 Å (Ultra-violet)	Per cent reacting to 4700–5280 Å (Blue-blue-green)	Relative physical intensity of each wave-length band
				Minutes			
1	117	38	62	15	44	56	100
1	94	40	60	15	41	59	25
1	98	35	65	20	53	47	11
1	107	20	80	25	58	42	6
1	101	39	61	25	56	44	4
1	108	21	79	30	61	39	3
1	122	14	86	15	38	62	100
1	119	32	68	15	25	75	25
1	98	9	91	20	45	55	11
1	114	4	96	20	34	66	6
1	115	5	95	20	45	55	4
1	108	0	100	20	52	48	3
1	115	14	86	15	37	63	100
1	116	11	89	15	25	75	25
1	125	39	61	15	50	50	11
1	152	20	80	40	40	60	6
1	136	23	77	50	47	53	4
1	160	34	66	30	31	69	100
1	221	22	78	30	44	56	11
1	133	36	64	35	54	46	3

The results of a similar test, with the Japanese beetle, in which one band was dropped after each test, are shown in Table 9. In four of the five tests blue-green was the least attractive color, and blue-blue-green nearly always the most attractive one. In the fifth test, where there was no choice, all went to blue-green, but only half the number of beetles reacted in comparison with previous tests.

In the next two series of tests, the insects were exposed to five bands extending from 5300 to 7400 Å and one band was dropped after each test, as formerly. In previous tests where the exposure was to 10 bands extending from 3650 to 7400 Å, that portion of the spectrum from about 5300 to 7400 Å was always relatively unattractive. Therefore, in Tables 10 and 11, the behavior is shown when the insects were given a choice in what previously was a series of unfavorable wave-length bands.

Forty per cent of the potato beetles in the first test went to yellow-green and the smallest percentage to infra-red. In the second test, with yellow-green omitted, the preference was for yellow-yellow-green. In fact, as the favorite color in each test was eliminated, the color nearest the omitted one, and the most distant from infra-red, became the favored one. This kept up until all went to infra-red, but a fewer number reacted. In fact, only 28 per cent reacted to infra-red while double this percentage reacted to the bands in the other tests.

In Table 11 the behavior of the Japanese beetle is shown to the same sort of tests. And in general the results are similar to those obtained with the potato beetle. However, with the third test to 3 wave-length bands, the number reacting declined and this decline was considerable when the beetles had no choice except infra-red. In this case only 2 per cent reacted, which is negligible.

From the behavior as indicated in Tables 8 to 11, it would appear that a certain proportion of potato beetles and Japanese beetles, when confined in a roomy apparatus, and exposed to various wave-length bands, will respond positively to almost every part of the spectrum between 3650 and 5660 Å at an intensity of 11. If the band in this portion of the spectrum is narrowed so that they are limited in their choice, in general they will respond just as well to the narrower portion.

TABLE 7

BEHAVIOR OF THE JAPANESE BEETLE, *Popillia japonica*, TO ULTRA-VIOLET AND BLUE-BLUE-GREEN LIGHT OF LOW INTENSITY IN COMPETITION WITH VARIOUS OTHER COLORS AT COMPARATIVELY HIGH INTENSITIES

No. tests	No. insects involved	Per cent not reacting	Per cent reacting	Exposure	Wave-length bands	Relative physical intensity	Per cent reacting	Wave-length bands	Relative physical intensity	Per cent reacting
				Minutes	*Ångstrom*			*Ångstrom*		
3	501	26	74	15	3650–3663	3	90	6620–7400	100	10
3	676	17	83	15	3650–3663	3	51	6120–6860	100	49
3	477	47	53	15	3650–3663	3	49	5900–6420	100	51
3	517	17	83	15	3650–3663	3	34	5500–6070	100	66
3	740	29	71	15	3650–3663	3	37	5300–5760	100	63
1	237	21	79	15	4700–5280	3	81	6620–7400	100	19
1	227	3	97	15	4700–5280	3	41	6120–6860	100	59
1	222	12	88	15	4700–5280	3	33	5900–6420	100	67
1	235	8	92	15	4700–5280	3	21	5500–6070	100	79
1	218	15	85	15	4700–5280	3	19	5300–5760	100	81
3	512	22	78	15	3650–3663	3	38	4420–5000	100	62
3	649	52	48	15	3650–3663	11	36	5900–6420	100	64
3	478	11	89	15	3650–3663	11	26	5500–6070	100	74

It is also indicated that when the same insects are exposed to various bands in that part of the spectrum between 5300 and 7400 Å at an introductory intensity of 11 a pronounced response will take place to every wave-length band except that of infra-red. If the band in this portion of the spectrum is narrowed, the greatest response will take place, as a rule, to the bands furthest removed from infra-red. Although the response to infra-red appears significant from a percentage standpoint, it is really not significant from the standpoint of actual numbers.

TABLE 8

BEHAVIOR OF THE POTATO BEETLE TO FIVE WAVE-LENGTH BANDS IN THE BLUE END OF THE SPECTRUM, WITH ONE BAND ELIMINATED AFTER EACH TEST

(Physical intensities of wave-lengths equalized at 11)

No. tests	No. insects involved	Per cent not reacting	Per cent reacting	Exposure	Wave-length band	Per cent reacting	Color of light transmitted
				Minutes	*Angstrom*		
1	157	50	50	30	3650–3663	28	Ultra-violet
					4120–4760	25	Violet-blue
					4420–5000	9	Blue
					4700–5280	23	Blue-blue-green
					4940–5660	15	Blue-green
1	180	48	52	30	3650–3663	28	Ultra-violet
					4120–4760	28	Violet-blue
					4420–5000	13	Blue
					4700–5280	31	Blue-blue-green
1	179	49	51	30	3650–3663	40	Ultra-violet
					4120–4760	40	Violet-blue
					4420–5000	20	Blue
1	149	51	49	30	3650–3663	38	Ultra-violet
					4120–4760	62	Violet-blue
1	141	58	42	30	3650–3663	100	Ultra-violet

It should be kept in mind that the behavior as reported in Tables 8 to 11 took place at an introductory intensity of 11, and that in all likelihood the ratios would be significantly changed if there was a corresponding change in the introductory intensity.

NOTES

All tests were made during daylight from 9:00 A.M. to 4:00 P.M., except for *Autoserica castanea.* This species exhibited little or no interest in light even after being kept in a dark place 10

or 15 minutes before testing. The tests as recorded were made at 9:00 P.M., D.S.T. As this is a nocturnal species we believe that an even greater percentage would have reacted if the tests had been made later in the evening.

The individuals of many species were in copulation during the tests, this being particularly true of *Chrysochus auratus*, *Macrodactylus subspinosus*, *Popillia japonica* and *Leptinotarsa decemlineata*. This and the gregariousness of some species may have added something to the number of individuals going to a certain color but not enough to warrant serious consideration. As a rule the three tests that were made for many species were fairly uniform.

TABLE 9

BEHAVIOR OF THE JAPANESE BEETLE TO FIVE WAVE-LENGTH BANDS, IN THE BLUE END OF THE SPECTRUM, WITH ONE BAND ELIMINATED AFTER EACH TEST

(Physical intensities of wave-lengths equalized at 11)

No. tests	No. insects involved	Per cent not reacting	Per cent reacting	Exposure	Wave-length band	Per cent reacting	Color of light transmitted
				Minutes	*Angstrom*		
1	370	30	70	15	3650–3663	11	Ultra-violet
					4120–4760	21	Violet-blue
					4420–5000	31	Blue
					4700–5280	30	Blue-blue-green
					4940–5660	7	Blue-green
1	357	38	62	15	4120–4760	24	Violet-blue
					4420–5000	23	Blue
					4700–5280	38	Blue-blue-green
					4940–5660	15	Blue-green
1	284	53	47	15	4420–5000	26	Blue
					4700–5280	52	Blue-blue-green
					4940–5660	22	Blue-green
1	294	32	68	15	4700–5280	81	Blue-blue-green
					4940–5660	19	Blue-green
1	245	65	35	15	4940–5660	100	Blue-green

In the case of *Apis mellifica*, field bees on their way out of the hive were used. It was found that if well fed the bees had a tendency to stay in the introduction chamber.

Tiphia vernalis (Hymen.). Males of this species were used twice, once on May 7 and again on June 14. After an exposure

of 20 minutes to 10 wave-length bands practically all the insects in both instances remained in the introduction chamber or the center of the apparatus. Apparently an introductory intensity of 3 was not a strong enough one to stimulate them.

Cryptorhynchus lapathi (Col.). This weevil was tested twice, about 130 adults being used in each test, but the response to the light was very poor. Ninety per cent of the beetles went either to the dark chamber or remained in the introduction compartment. These tests were made on July 8 at an introductory intensity of 3.

Cicindela repanda (Col.). Fifty adults of this tiger beetle were exposed twice on August 22, once at an introductory intensity of 3 and again at an introductory intensity of 11. In both cases practically all the beetles remained where they were first introduced. In comparison with bright sunlight to which these insects are frequently accustomed, both our introductory intensities must have seemed like darkness to them. They moved only when a moving object such as a hand approached them in order to pick them up. It was unexpected to find these active insects, after an exposure of 15 minutes, in exactly the same place where they had been introduced. Some had not moved at all and others had not moved more than an inch or two. They seemed to be hypnotized at the low intensities of the various wave-lengths.

Aedes ægypti (Dip.). Two hundred and fifteen adults of the yellow fever mosquito were tested on September 24 at an introductory intensity of 3 and not a single one went to any of the 10 wave-length bands. Seventy-five per cent remained in the introduction chamber and 25 per cent went to the black chamber.

Pyrausta nubilalis (Lep.). Adults of this species were tested in lots of 100 and more during the daytime on May 20 and May 26, at an intensity of 3. After an exposure of 35 minutes in one case and 60 minutes in another only a few insects were found in the ultra-violet and blue-blue-green compartments. Most of them were in the introduction compartment. Different results might have been obtained if the testing had been done at night.

SUMMARY AND DISCUSSION

Twenty-nine species of insects, mostly Coleopterous and diurnal, were exposed to from eight to ten light bands of equal physi-

cal intensities in that part of the spectrum from 3650 to 7400 Ångstrom units. The physical intensities of the wave-lengths were equalized by the methods set forth in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, Vol. XLIX, p. 1–20, 1941. The introductory intensities of the wave-lengths were changed in some cases by exposing the insects at different distances from the source of light. When the insects under consideration were exposed to the various colors at an introductory intensity of 100 the peak response, for most of them, took place at 4700–5280 Å (blue-blue-green). When the introductory exposure was at an intensity of 3, the peak response took place at 3650–3663 Å. In nearly all cases the responses to 5550–7400 Å were insignificant, when the insects were exposed to the blue end of the spectrum as well.

TABLE 10

BEHAVIOR OF THE POTATO BEETLE TO FIVE WAVE-LENGTH BANDS IN THE SPECTRUM FROM GREEN TO INFRA-RED WITH ONE BAND ELIMINATED AFTER EACH TEST

(Physical intensities of wave-lengths equalized at 11)

No. tests	No. insects involved	Per cent not react-ing	Per cent react-ing	Expo-sure	Wave-length band	Per cent react-ing	Color of light transmitted
				Minutes	*Ångstrom*		
1	144	54	46	30	5300–5760	40	Yellow-green
					5500–6070	21	Yellow-yellow-green
					5900–6420	26	Yellow-orange
					6120–6860	10	Orange-red
					6620–7400	3	Infra-red
1	150	52	48	30	5500–6070	46	Yellow-yellow-green
					5900–6420	18	Yellow-orange
					6120–6860	24	Orange-red
					6620–7400	12	Infra-red
1	135	58	42	30	5900–6420	66	Yellow-orange
					6120–6860	23	Orange-red
					6620–7400	11	Infra-red
1	121	55	45	30	6120–6860	76	Orange-red
					6620–7400	24	Infra-red
1	110	72	28	30	6620–7400	100	Infra-red

The behavior of the potato beetle and the Japanese beetle to

ultra-violet and blue-blue-green in competition with each other indicated that the sensitivity of the insects to these wave-lengths or colors, varied in accordance with the introductory intensities.

Tests made with the Japanese beetle alone, using ultra-violet and blue-blue-green in competition with 5 wave-lengths or colors mostly in the so-called red end of the spectrum indicated that parts of the red end at intensities of 100 are more attractive than ultra-violet and blue-blue-green at intensities of 3.

TABLE 11

BEHAVIOR OF THE JAPANESE BEETLE TO FIVE WAVE-LENGTH BANDS IN THE SPECTRUM FROM GREEN TO INFRA-RED WITH ONE BAND ELIMINATED AFTER EACH TEST

(Physical intensities of wave-lengths equalized at 11)

No. tests	No. insects involved	Per cent not reacting	Per cent reacting	Exposure	Wave-length band	Per cent reacting	Color of light transmitted
				Minutes	*Ångstrom*		
1	320	33	67	15	5300–5760	21	Yellow-green
					5550–6070	33	Yellow-yellow-green
					5900–6420	30	Yellow-orange
					6120–6860	16	Orange-red
					6620–7400	0	Infra-red
1	288	35	65	15	5550–6070	36	Yellow-yellow-green
					5900–6420	32	Yellow-orange
					6120–6860	29	Orange-red
					6620–7400	3	Infra-red
1	230	60	40	15	5900–6420	57	Yellow-orange
					6120–6860	36	Orange-red
					6620–7400	7	Infra-red
1	187	68	32	15	6120–6860	83	Orange-red
					6620–7400	17	Infra-red
1	176	98	2	15	6620–7400	100	Infra-red

Additional tests with the potato beetle and Japanese beetle, in which they were exposed at first to five wave-length bands which were progressively reduced to one, indicated that at an intensity of 11, in the absence of a favored color, these insects will respond to all test colors except infra-red.

In view of these results with the species under consideration it is apparent that they behaved as if they had wave-length or

color discrimination. With the physical intensities of the colors equalized, and at a certain introductory intensity at exposure to the colors, an almost uniform type of behavior pattern was apparent for many species, with the most stimulating part of the spectrum being confined to certain of the shorter wave-lengths. When the introductory intensity was changed the behavior pattern changed also, this change taking place in the response to the blue end of the spectrum and involving specifically the sensitivity of the insects to 3650–3663 Å, and 4700–5280 Å.

These and the other types of behavior to colors which occurred when the physical intensities were changed suggest that the stimulating values of the wave-lengths may be due in large part to their apparent luminosity, or to some other effect of wave-length and intensity upon the visual apparatus. Although apparent luminosity can only be inferred from the actions of the insects, it seems to offer a satisfactory explanation for the varied behavior. It is our belief that of the two factors, wave-length and intensity, the latter is by far the most important. Of course the relative importance of each can only be determined by experimental work designed to bring out the thresholds of reflex action for various species exposed to different wave-lengths at different intensities.

It should be kept in mind that the work reported upon in this and the two previous papers is intended to be exploratory rather than exhaustive in any particular aspect. After studying the general behavior of many species to various wave-lengths, information is obtained that is invaluable in planning further work in a narrower and more specialized phase. The results therefore, so far, should be interpreted as indicating trends of behavior for large numbers of insects rather than as types of behavior that are fixed and inflexible. Not all individuals in a group of one species or another are equally photosensitive at the same time. Our specimens, as they were collected in the field, included individuals of different ages and certainly many of them were under outer and internal stimuli that modified or inhibited their response to light. Care was taken to use fresh specimens in every test. When this was not possible, the tests were discontinued when it became apparent that too much handling or too many successive exposures were reducing their sensitivity.

Although artificial light is a poor substitute for sunlight, the use of reflected sunlight of uniform and constant quality seems unattainable. And although the tests were artificial in that insects are not called upon in nature to make choices between such wave-lengths as we placed before them, no better method presented itself. Out of doors, insects are subjected to a variable

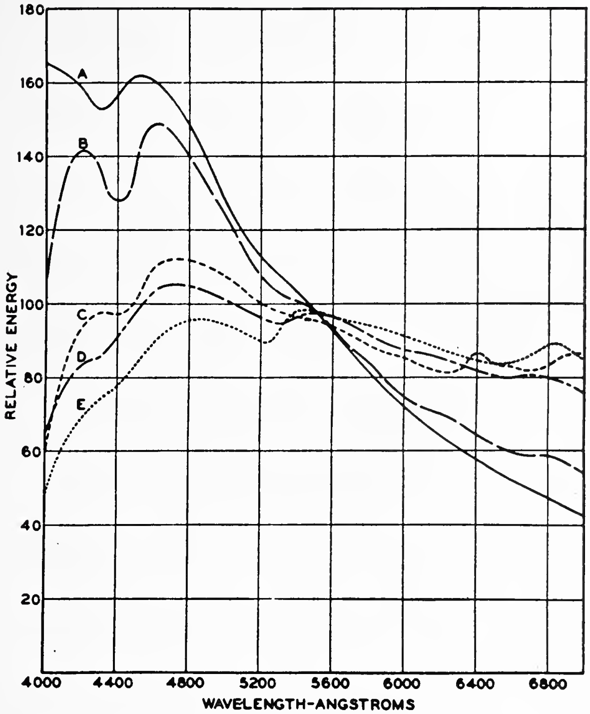

FIG. 6. Average energy distribution curves for following types of daylight: (A) Zenith sky, color temperature 13,700° K; (B) North sky on 45° plane, color temperature 10,000° K; (C) Totally overcast sky, color temperature 6500° K; (D) Sun plus sky on horizontal plant, color temperature 6000° K; (E) Direct sunlight, color temperature 5335°K. (After A. H. Taylor and G. P. Kerr.)

distribution of energy in the visible spectrum of daylight. Haze, dust, clouds, smoke absorb certain wave-lengths. Taylor and Kerr, who have recently measured the relative spectral energy distribution of daylight, show in a recent paper some of the nor-

mal variations in the distribution of energy from 4000 to 7000 Å. While these variations represent only a small part of the entire range found in nature they do not seem to be very great for sunlight and are not nearly so great as the changes in introductory physical intensities to which we subjected our experimental insects. For example a reduction in relative physical intensity from 100 to 3 is approximately a change of 3300 per cent. Such relatively small comparative variations as occur in nature during the mid-day sunlight hours, in which many insects are active, probably influence insect behavior little or not at all.

When we used 100 watt lamps instead of 40 watt lamps, thereby increasing the physical intensity approximately 250 per cent, the responses of the species showed no appreciable change. Figure 7 shows average energy distribution curves, for certain types of daylight, as plotted by Taylor and Kerr.

Acknowledgments

For supplying the specimens used in the tests we are greatly indebted to Mr. Robert J. Sim, Mr. Paul L. Holcombe, Mr. Lewis P. Hoagland, Mr. C. W. Collins, Mr. Max P. Zappe, Dr. Philip Garman, Dr. J. L. King, Dr. R. W. Glaser, and Mr. John H. Harman.

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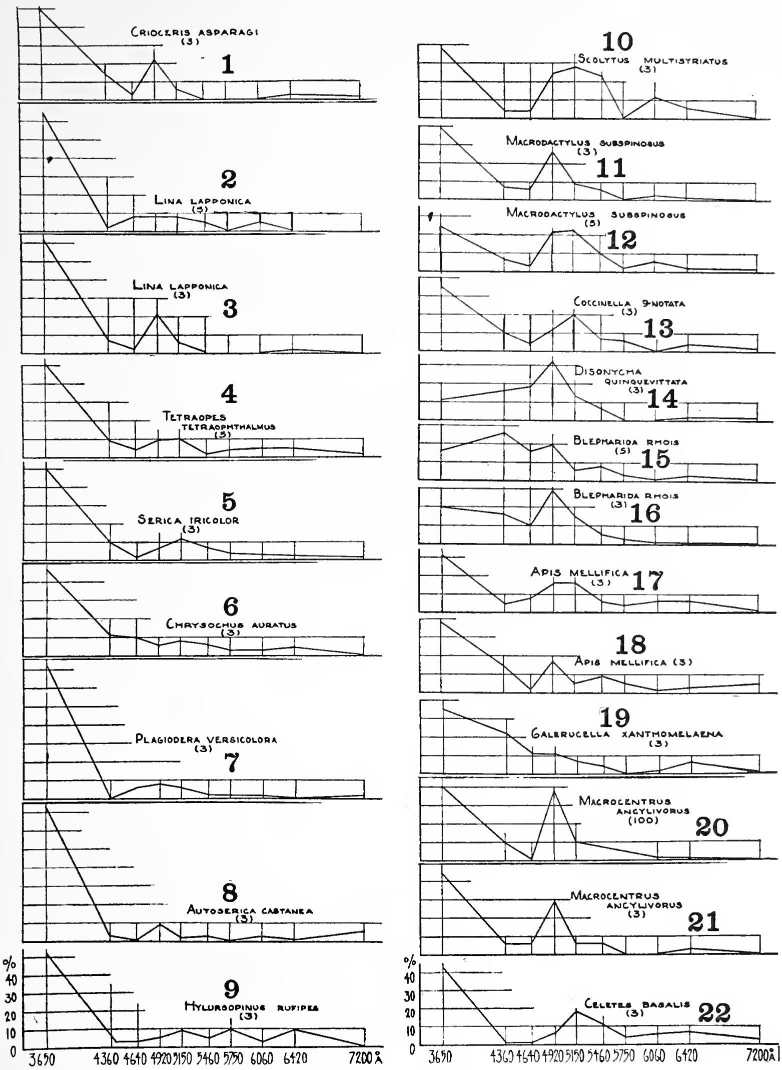
PLATE I

Figure 1. *Crioceris asparagi*
Figure 2. *Lina lapponica*
Figure 3. *Lina lapponica*
Figure 4. *Tetraopes tetraophthalmus*
Figure 5. *Serica iricolor*
Figure 6. *Chrysochus auratus*
Figure 7. *Plagiodera versicolora*
Figure 8. *Autoserica castanea*
Figure 9. *Hylurgopinus rufipes*
Figure 10. *Scolytus multistriatus*
Figure 11. *Macrodactylus subspinosus*
Figure 12. *Macrodactylus subspinosus*
Figure 13. *Coccinella 9-notata*
Figure 14. *Disonycha quinquevittata*
Figure 15. *Blepharida rhois*
Figure 16. *Blepharida rhois*
Figure 17. *Apis mellifica*
Figure 18. *Apis mellifica*
Figure 19. *Galerucelia xanthomelaena*
Figure 20. *Macrocentrus ancylivorus*
Figure 21. *Macrocentrus ancylivorus*
Figure 22. *Celetes basalis*

NOTE: Figures in parentheses below names on plate indicate the relative intensities of wave-lengths.


1 Crioceris asparagi (3)
2 Lina lapponica (5)
3 Lina lapponica (3)
4 Tetraopes tetraophthalmus (5)
5 Serica iricolor (3)
6 Chrysochus auratus (3)
7 Plagiodera versicolora (3)
8 Autoserica castanea (3)
9 Hylurgopinus rufipes (3)
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3650 4360 4640 4920 5150 5460 5750 6060 6420 7200 Å
10 Scolytus multistriatus (3)
11 Macrodactylus subspinosus (3)
12 Macrodactylus subspinosus (5)
13 Coccinella 9-notata (3)
14 Disonycha quinquevittata (3)
15 Blepharida rhois (5)
16 Blepharida rhois (3)
17 Apis mellifica (3)
18 Apis mellifica (3)
19 Galerucella xanthomelaena (3)
20 Macrocentrus ancylivorus (100)
21 Macrocentrus ancylivorus (3)
22 Celetes basalis (3)
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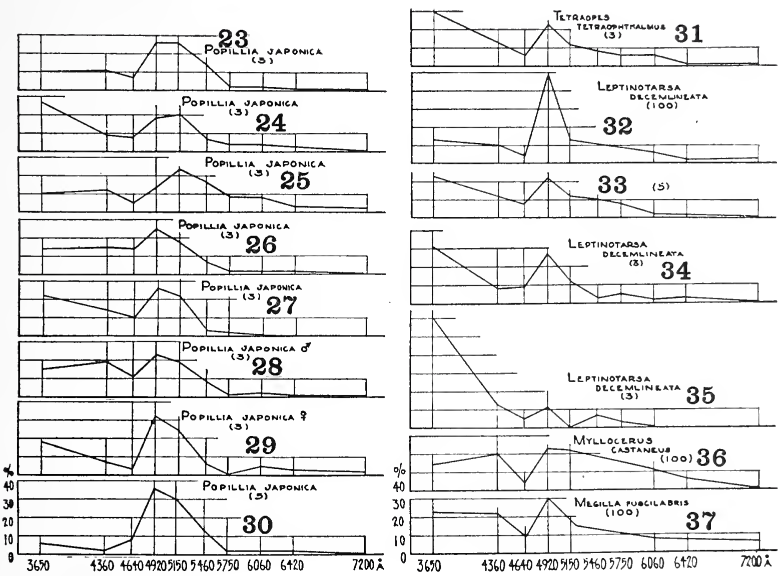
PLATE II

Figure 23. *Popillia japonica*
Figure 24. *Popillia japonica*
Figure 25. *Popillia japonica.* Filter positions in disarray.
Figure 26. *Popillia japonica*
Figure 27. *Popillia japonica*
Figure 28. *Popillia japonica*
Figure 29. *Popillia japonica*
Figure 30. *Popillia japonica*
Figure 31. *Tetraopes tetraophthalmus*
Figure 32. *Leptinotarsa decemlineata*
Figure 33. *Leptinotarsa decemlineata*
Figure 34. *Leptinotarsa decemlineata*
Figure 35. *Leptinotarsa decemlineata*
Figure 36. *Myllocerus castaneus*
Figure 37. *Megilla fuscilabris*

NOTE: Figues in parentheses below names on plate indicate the relative intensities of wave-lengths.



23 POPILLIA JAPONICA (3)
POPILLIA JAPONICA (3) 24
POPILLIA JAPONICA (3) 25
POPILLIA JAPONICA (3) 26
POPILLIA JAPONICA (3) 27
POPILLIA JAPONICA ♂ (3) 28
POPILLIA JAPONICA ♀ (3) 29
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TETRAOPES TETRAOPHTHALMUS (3) 31
LEPTINOTARSA DECEMLINEATA (100) 32
33 (5)
LEPTINOTARSA DECEMLINEATA (3) 34
LEPTINOTARSA DECEMLINEATA (3) 35
MYLLOCERUS CASTANEUS (100) 36
MEGILLA FUSCILABRIS (100) 37
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3650 4360 4640 4920 5150 5460 5750 6060 6420 7200 Å

BOOK NOTICE

Butterflies. A Handbook of the Butterflies of the United States, Complete for the Region North of the Potomac and Ohio Rivers and East of the Dakotas. By Ralph W. Macy and Harold H. Shepard. The University of Minnesota Press, Minneapolis, 1941. Cloth, 6 × 9 inches, viii + 248 p. Four color plates and 52 text illustrations. $3.50.

The introduction to this book is worth reading for it gives an informative, general survey of present-day knowledge of butterflies and the methods pursued in their study. A map defines the general area considered and a map of Minnesota, showing life zones, is valuable because of the many Minnesota records listed at the end of each description.

As the book is written for the general use of the many people who are interested in natural history, but who are not trained taxonomists, the whole presentation is very simple and avoids technicalities. Thus the systematic account starts with a short family key. In the text each family is briefly defined and followed by a key to the species. Four families, Danaidæ, Satyridæ, Nymphalidæ and Libytheidæ are handled in one key which is a successful solution for the few species included. In presenting the Hesperiidæ, the subfamily Pyrginæ has a key to the genera with further keys to the species. The Hesperiinæ are divided into four generic groups by key and each group subdivided to genera, and where needed to species by keys. The scheme is comprehensible to the amateur and makes accurate determination of the northeastern species possible.

The index includes both popular and scientific names and each description of a species is headed by the scientific name followed by the popular name. The references to the literature are confined to the original descriptions and readily obtainable popular works. Information on life history briefly describes egg, larva and pupa, mentioning food plants and habits.

There are 45 text figures, principally of Hesperiidæ and four colored plates showing 29 species in reduced size. The plates seem somewhat of an afterthought for they are not referred to in the text.

The book is a useful addition to popular butterfly literature. Its claim: "Complete for the Region" is unfortunate for three species distinctly from the region are omitted.—W. P. Comstock.

ON BORDER-LINE DIRCENNA (LEPIDOPTERA, ITHOMIINÆ)

By Wm. T. M. Forbes
Cornell University, Ithaca, New York

The following little group of species has been standing in our lists as Episcada and Pteronymia, but is obviously much closer to the *lenea* group, generally considered a section of Dircenna. We have long recognized them as a distinct group, not specially related to Episcada and Pteronymia, but held off because the Cornell collection only contained a single damaged male. Males of two more species in the American Museum of Natural History show that the group is a sound one. Superficially they look a little like some of the aberrant Dircennas, but not at all like the typical and *lenea* groups. They may be distinguished from all the other Ithomiinæ known to me by the lower discocellular of fore wing being angulated far below its middle, with vertical upper sector.

Hyalenna, new genus

General characters of Ithomia and Dircenna, as given by Staudinger and Schatz (Exotische Tagfalter, Familien und Gattungen 95, 96). Sides of thorax with shaggy bands of long hair as in normal Dircenna, unlike the majority of the Ithomia group; first two segments of abdomen lightly hairy. Fore wing normal except the closure of the cell; mdcv long and erect; ldcv not longer, right-angled and bearing the medial spur well below its middle, the upper half continuing the general line of mdcv. Hind wing of male with Sc closely parallel to cell for a distance at base, then diverging to enclose a long-fusiform sex-patch, but again approaching beyond it and fading out before end of discal cell, hair pencil toward base of cell only; udcv very short and oblique out, mdcv moderate, oblique in, ldcv much longer, angulate and bearing the M-spur, its upper sector rather short and oblique in, the lower oblique out and convex outward. Female hind wing with Sc and R closely parallel for nearly half length of cell, Sc then diverging and ending rather beyond end of cell; discocellulars about as in male, but upper even shorter; hum in both sexes recurrent to basal angle, simple or with slight vestige of the outer branch. Male fore leg with tibio-tarsus a knob, densely hairy; female (Fig. 5) with fifth segment markedly developed and first three segments spined, essentially as in "*D.*" *lenea* (Fig. 4). Scaling of wings slight, mostly limited to veins and decidedly narrow borders.

This genus will run in Fox's male key (Trans. Am. Ent. Soc., lxvi, 169, 1940) to Dircenna, from which it differs by the ldcv of fore wing and different appearance. The female will run to alternative 7, but the length of M-spur and exact length of the closely parallel portions of Sc and R are variable and it may run to Dircenna, Corbulis or Oleria; from all of these it differs by the ldcv of fore wing, and from Oleria by the different course of R of hind wing.

The male genitalia are essentially as in *D. lenea:* uncus and valves simple; costa not much enlarged, penis simple (though not lengthened as in the *lenea* group) but with a large triangular gnathos (subscaphium) as in others of the Dircenna group; it will run in Kremky's key (Ann. Zool. Mus. Pol. Hist. Nat., iv, 181, 1925) to Episcada, as will also *D. lenea.*

KEY TO SPECIES

1. Fore wing with a yellow bar at end of cell, extending down to M_3, very broad, and including the parts of the veins crossing it .... *alidella*
–. Fore wing with pm band whitish or white, and cutting Rs and M_1 very shortly, or obsolete, never cutting M_2 2
2. Outer part of transparent ground as seen against a dark background with a series of 5 whitish shades in interspaces just before border; border brown 3
–. A small whitish spot in cell M_3 and minute one in Cu_1 only; border black .... *teresita*
3. Border of hind wing below plain light tawny; expanse 70 mm. ..... *perasippe*
–. Border of hind wing below with four white submarginal spots, the first in female rounded, the rest linear, all inconspicuous in male; expanse 60 mm. .... *maculata*

CATALOGUE OF SPECIES

(For further bibliography see Bryk, Lep. Cat., lxxx, 1937.)

alidella Hew. (*Ithomia*) Ill. Exot. Butt., iv, Ithomia, 27: 174, 1869; Weymer Berl. Ent. Zeit., xliv, 308, 1899 (to *Episcada*); Haensch, Berlin Ent. Zeit., xlviii, 197, 1903 (to *Pteronymia*). Colombia

a. dirama Hsch. Berl. Ent. Zeit., l, 172, 5: 19: 1905 (as sp. of *Episcada*); Seitz, v, 39: f1.[1] Bolivia

[1] Not seen and no characters given to distinguish it from typical *alidella;* presumably a race, as given in Seitz.

teresita Hew. (*Ithomia*) Ill. Exot. Butt., iii, Ithomia, 24: 148, 1863; Hsch. Berl. Ent. Zeit., xlviii, 200, 1903 (to *Pteronymia*); l.c., l, 172, 1905 (to *Episcada*); Seitz, 40: a5 ♂, b1 ♀[2] (male genitalia Fig. 1). Ecuador, Colombia

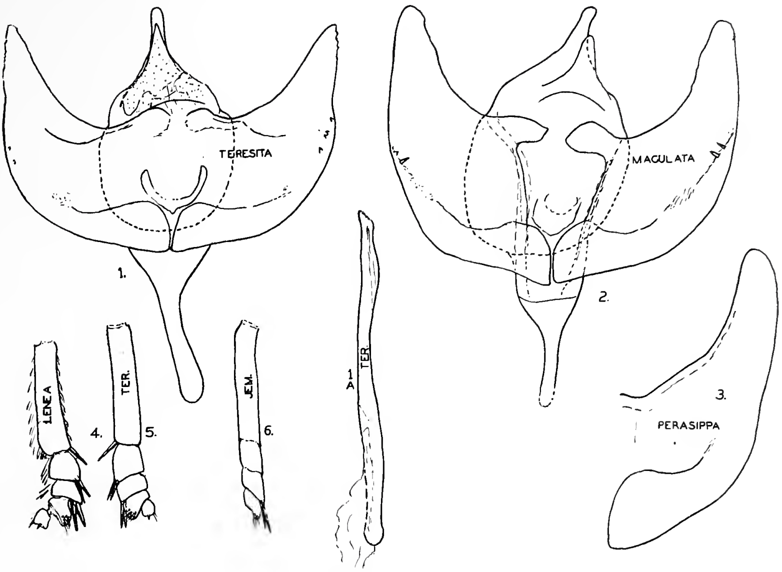

Figure 1. 1. *Hyalenna teresita,* male genitalia, with ædœagus drawn separately (1A); 2. *H. maculata,* male genitalia; 3. *H. perasippe,* male valve; 4. *Dircenna lenea,* female fore tarsus; 5. *Hyalenna teresita,* female fore tarsus; 6. *Dircenna jemina* (genotype), female fore tarsus. All the figures are drawn to the same scale.

perasippe Hew. (*Ithomia*) Equat. Lep., v, 85, 1877; Haensch in Seitz Macrolep. World, v, 151, 39: e6, 1909 (to *Episcada*) (male genitalia Fig. 3). Ecuador, Colombia

maculata Röber (*Episcada perasippa m.*) Ent. Zeit. (Int. Ent. Ver.), xliv, 21, 1930.[3] W. Colombia

[2] The M-spur is shown in normal position in both Hewitson's and Haensch's figures, but I believe I have the correct species. Still to satisfy the nomenclatorial purists I formally cite as type perasippe *as figured in this paper.*

[3] The original description is rudimentary, but mentions the white marginal spots. The male genitalia (Fig. 2) show it is a distinct species, and we have both from Pacho, Colombia.

THE LENEA GROUP

Dircenna lenea (Fig. 4) and a few related species differ from *jemina* (the genotype) and several other species in lacking the four-segmented tarsus (Fig. 6), given as a chief character for the genus by both Schatz and Fox. But it should be noted that while

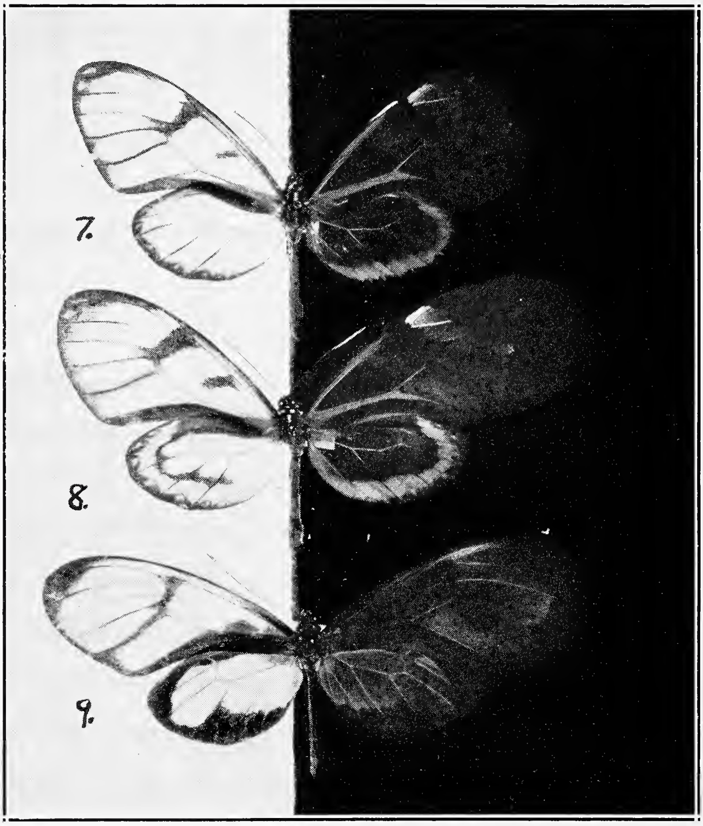

Figure 2. 7. *Dircenna chloromeli,* holotype ♀; 8. *D. chloromeli,* allotype ♀; 9. *Dircenna rufa,* holotype ♀.

jemina is doubtless validly chosen as the genotype, Doubleday in the original description gave the tarsus as five-segmented and included the *lenea* group.

For the moment I refer only to the species which have a black, tawny or smoky triangle in the cell instead of a transverse bar

(only faintly visible in ♂ *methonella*), although some further species have the five-segmented tarsus. It is possible these should be transferred to Hyalenna. Bryk divided them erratically between Dircenna and Epithomia, putting *xantho* with its more familiar race *methonella* in the latter and *hulda* with them, though the remaining forms of *lenea,* and *pulcheria* remain in Dircenna. Perhaps this whole group should be transferred to Hyalenna, but on superficial structures it is a Dircenna. I have not studied *pulcheria,* which should belong here, and have seen nothing like *hulda,* which should be a suffused type, more extreme than a couple of females of *lenea drogheda* which we have from Venezuela. The residue will key as follows:

1. Abdomen with a subdorsal series of white spots; costal area of hind wing below tawny, heavily defined below with black .... *lenea*
–. Abdomen dorsally wholly blackish, with subventral yellow or white stripes or spots only 2
2. Translucent area rather evenly dull tawny, contrasting with the black borders and markings; tawny of under side of hind wing suffusing up to costal edge .... *rufa*
–. Translucent area yellow or partly shaded with tawny; costa of hind wing below black, with at least a couple of contrasting yellow or white spots (normally a basal yellow spot, a costal streak in male, and two white spots in female) .... *xantho*

This analysis puts a whole list of supposed "species" as mere races and varieties of *lenea.* In general there are two main types, a northern one with heavy tawny shadings, and no band across the hind wing and a Peruvian one without tawny but with heavy black markings on a honey-yellow ground, including a bar across hind wing at end of cell; in the Amazon basin there is every possible intergrade, with a tendency to have the black and yellow pattern of the Peruvian form but with a tawny subterminal band on hind wing, sometimes visible only on the underside. The names for these three types are: 1, *lenea, hulda, drogheda;* 2, *zelie, epidero; signata* and *obfuscata* belong to the Amazonian types with some submarginal orange. It may be possible to treat some further names as statistical races, *e.g., drogheda* normally has tawny subapically on the under side and very frequently suffused females, but even *zelie* and *signata* have a large blend zone on the middle Amazon (Maués). I have seen a partly tawny form

labelled *zelie,* but the original description calls for black and yellow only, and Bolivia is well out of the range of the tawny forms.

The *xantho* forms are very close to the *lenea* forms but can apparently be separated by the black abdomen; in their black and yellow phases (*zelie* and *methonella*) they can also be separated by the costal pattern below, but we are not sure if this will hold of typical *xantho. Methonella* also lacks a densely scaled pale yellow submarginal bar in cell M_3 of fore wing, which is rarely if ever absent in *zelie,* but according to the original description this bar is present in *xantho.*

Dircenna rufa, new species

Head and thorax black, spotted above with white (yellow in typical *lenea*); back of thorax and base of abdomen dusted with yellow, the latter with short white subdorsal stripes, abdomen otherwise solidly smoky above (like *xantho,* unlike all *lenea* forms), beneath with thin yellow subventral stripes, much narrower than in tawny-marked phases of the other species. Antennæ black, with yellow clubs.

Ground of wings translucent tawny, with some yellow scaling not producing any pattern, dominant over the tawny only at costa beyond cell and vaguely before outer margin, where *lenea* forms may have whitish scaling; markings black, not quite opaque; a triangle resting on lower side of cell, a bar across upper angle of cell from costa at base of R to outer margin at Cu_1, a little widened at upper and lower angles of cell, and widened triangularly at outer margin; the space between it and costa filled with denser tawny scaling; costa blackish above cell to $\frac{1}{3}$, then costal edge only black for a ways, but widening into the black apex. Outer margin narrowly black to Cu_1, then more widely to anal angle; inner margin black below Cu and Cu_2; veins tawny except in the black borders where they are black, including the whole of A, the other veins partly scaled with black where they cross the black markings. Hind wing also transparent tawny, denser along the veins; borders black, fully scaled, the costa black down almost to the M-spur, beyond the cell almost to M_2, then more narrowly postmedially but widening again to apex, narrowing to half as broad on outer margin in cell M_3 and very broad from there to anal angle, with a cusp running half way in to cell along Cu_1; mdcv contrasting, tawny, cutting the costal black, the other veins concolorous. Under side similar, the black everywhere more restricted, fore wing with three st. spots at apex, preceded by a tawny dot in fork of R_{4-5}, the triangle in cell wanting; *hind wing without any black border above cell,* there being only a black bar in base of cell, and the black costa starting at end of cell; outer border with three white dots at apex and four on inner margin, the one in cell M_3 missing. Expanse 65 mm.

Rioja, Moyobamba, Peru, 1 ♀ type in Cornell University collection.

This species may be related to *pulcheria* Hew., but the latter as described has much more complicated markings, suggesting rather a form of *lenea.*

The following species looks much like a *lenea* form, but shows the normal four-segmented tarsus and black bar across the cell of typical Dircenna. The tawny border especially suggests *lenea,* but shows no sign of the restriction or interruption in cell M_3. It looks at first glance like a Eutresis or a Ceratinia.

Dircenna chloromeli, new species

Male fore tibio-tarsus hairy at tip as in normal Dircenna, in one of the two specimens half as long as femur, in the other normal; female with the usual swollen base of tibia, frequent in Dircenna. Male hind wing with simple pencil, female with Sc and R closely parallel half length of cell, then connected.

Head as well as body spotted with yellow, even with some yellow scaling of coxæ and palpi; abdomen smoky above, pale yellow and cream below.

Ground transparent, very pale yellow; fore wing as seen against a white background with a broad tawny costal stripe to end of cell, and dorsal stripe along base of Cu and out along Cu_2, besides the extension of the veins; cell bar oblique, rather narrow, resting on R but not crossing cell, blackish; bar at end of cell blackish, extending $\frac{1}{4}$ way to margin in cell M_2, down along m–cu, and out in vein-stripes along M_3 and Cu_1 to margin, followed by a solid yellow bar at costa, which lies wholly above Rs. Costa black, on the basal two thirds hardly more than the costal edge, but abruptly widening beyond the yellow pm bar, much widened over the apex, especially in the female, and continued along outer margin, where it extends in on the veins. Inner margin blackish $\frac{2}{3}$ way in to the cell, and up to Cu beyond the end of the tawny dorsal stripe, sometimes leaving the inner edge tawny; veins basally tawny around cell, including bases of M_3, Cu_1 and Cu_2, but A and veins outwardly black. Hind wing with a broad tawny border extending a third way in to cell and inwardly edged with smoky, cell M_3 not specially marked; margin blackish with the white submarginal spots of under side partly showing through; veins mainly tawny with some yellow scales, but blackish about where they cross the black pattern-elements. Costa of male with a smoky streak below the usual sex-scaling, female with the tawny border extending around apex almost to end of cell, the rest of costa umber down almost to M_2 and the M-spur, where it is edged with orange.

Against a dark background part of the translucent ground shows as smoky, leaving the yellow in cell as two separate patches, two rows of spots beyond

cell, the pm. ones large and fused, the st. ones smaller with the one in cell R_5 sometimes absent and that in M_2 more or less completely fused with the post-medial one, only a narrow streak in cell M_3 and the patch in Cu_1 also not nearly filling its cell; hind wing also showing a broad smoky stripe between the yellow disc and the fully scaled border. Under side much the same, fore wing with three or four triangular terminal white spots, hind wing with a complete series much closer to the margin than usual in Dircenna, narrowly defined with black, the terminal being a mere line; costa broadly tawny but with a complete black stripe between it and cell.

Pará, Brazil, type male and paratypes male and female in Cornell University collection.

It is hard to believe so striking a species has been overlooked, but I cannot find a description of it. It could possibly be taken for a Ceratinia or even a Pteronymia.

A NEW PARASITIC FLY (CUTEREBRIDÆ) FROM THE NORTHERN WHITE-FOOTED MOUSE

BY HERBERT T. DALMAT
NEW YORK CITY

In 1939 at Ames, Iowa, *Peromyscus leucopus noveboracensis* (Fischer) was found to act as host of cuterebrid larvæ. To learn more about this infestation the author carried on extensive trapping of the mouse at Ames between the months of August and November in 1940 and 1941. A fly reared from larvæ taken from these mice proved to be the new species described below.

In 1940 there was an infestation of 38 per cent between September 15 and November 2, and in 1941 the percentage was even higher.* The first stage larvæ probably enter such part of the host as happens to be most convenient. Emasculation was encountered in more than 75 per cent of the cases probably because the scrotal skin is thin and is more apt to come in contact with the eggs or larvæ which, in the writer's opinion, are deposited on the nesting material of the mouse or on the foliage around the burrows.

Cuterebra peromysci new species.

MALE (Holotype)

Length, 15.3 mm. Maximum width of abdomen, 6.2 mm. Mesonotum 4.6 mm. wide; scutellum 2.8 mm. wide, 1.5 mm. long.

Width of cephalic capsule through vertex, 5.4 mm. Distance between eyes at vertex, 1.1 mm. (Ratio 5 to 1.) Outer ocellar triangle raised above level of front. Antennal grooves together forming an oval depression, 1.7 mm. long and 1.5 mm. wide, completely circumscribed, divided down the center by a carina. Carina concave when viewed in profile. Antennal grooves covered with silvery pollen except on ventro-lateral regions which are strongly shining and almost black. Antennæ and aristæ brown. Antennæ covered in part by silvery pollinosity; a cluster of white hairs on both first and second antennal segments. Aristæ ciliate above, with two hairs below on the distal end.

* Dalmat, Herbert T. Infestation of the Northern White-footed Mouse with a New Species of a Parasitic Fly (Cuterebridæ) and Notes on Other Ectoparasites. Unpublished paper, 1941.

Cheek grooves deep. Entire head below cheek grooves white pollinose* and covered with white hair except for two shining areas, a brown one on lower margin of eye and a larger black one about midway between it and mouth. White pollinosity of buccæ extending slightly up the parafacials. Frontal vitta, ocellar triangle, and facial ridge covered with grayish-white pollen. Parafacials, parafrontals, and outer ocellar triangle dark brown and shining; black hairs sparsely covering these areas as well as the frontal vitta and vertex, the hairs more dense on vertex and dorsal region of parafrontals bodering outer ocellar triangle. Oral aperture arch-shaped, the apex at anterior end.

Four white pollinose areas on each side of head. Lowest area in the form of a triangle on parafacial just dorsad to cheek groove, contiguous with inner margin of eye, and continuous with pollen of bucca. Upper three areas forming a triangle, two spots contiguous with inner margin of eye, the small third one near dorsal limit of ptilinal suture. Uppermost spot contiguous with, and extending parallel to, margin of eye between facial depression and vertex; the one below it immediately dorsad and parallel to ridge running laterad from ptilinal suture almost to eye. Occiput completely white pollinose, clothed with white hairs.

Thorax black above with grayish bloom, subopaque; black hairs on dorsal surface approximately 0.5 mm. long, the distance between adjacent hairs about 0.05 mm. Pleura covered by white pollinosity and dense, long, white hairs, the length of hairs about 0.9 mm. A small cluster of black hairs near anterior dorsal corner of mesopleuron; two dark brown shining areas above insertion of anterior coxæ. Legs clothed with black pubescence except for narrow band of white hairs running down outside of femora of forelegs; entirely lacking pollinosity. Pulvilli fuscous.

Abdomen iridescent blue. First segment destitute of pubescence except for single row of white hairs on anterior margin and row of black hairs on posterior margin; entirely covered with faint white pollen.

Second, third, and fourth abdominal segments with white pollen in wide, irregular bands on dorsa, mainly on anterior margins, extending to lateral regions of abdominal segments and ventrally to the borders of the tergites. Pollinosity not symmetrical, interrupted by dark brown shining areas. Hairs on dorsa of these segments black; those on second segment long and slender, increasing in length from the median-dorsal line to the lateral regions, at least twice as long and more flexuous than those on third and fourth segments. Hairs of third and fourth segments approximately 0.2 mm. long, somewhat stiff.

Fifth segment completely encircled by dense white pollen and white hairs except for round, dark, shining areas as on second, third, and fourth segments. Strongly shining black band at extreme posterior margin of segment. White hairs of fifth segment 0.34–0.4 mm. long.

* The pollinosity on *Cuterebra* species is often masked by oil exuding from the bodies. The author found that emersion in chloroform removed the oil from the flies, permitting the actual colors to be seen.

Long white hairs on lateral margins of tergites of fourth and fifth segments.

Sixth segment with sparse white pubescence. Gray pollen in band on posterior border and elsewhere in irregular patches. Microscopic hairs composing pollen longer and slenderer than those composing pollen on other parts of body. Sixth segment well hidden beneath fifth, surrounding gentalia.

Sclerites surrounding genitalia covered with white hairs. Sternites with gray pollinosity and long black hairs.

After studying the descriptions of the known cuterebrids and examining several species in the collection of Myron H. Swenk,* the author finds that the species described above is in the *fontinella* group and is most closely related to *Cuterebra fontinella* Clark and *C. fasciata* Swenk.

C. peromysci is distinguished from *fontinella,* as described by Clark in 1827, by having all the abdominal segments strongly pollinose on the dorsal as well as on the lateral areas, while the abdomen of *fontinella* is pollinose only on the last two segments.

C. peromysci differs from the specimen determined by Swenk as *fontinella* by the pollinosity and pubescence of the abdomen and legs, the hairs of the pleura, and the pubescence of the head. In *fontinella* the lateral areas of the third and fourth abdominal segments and the entire fifth segment are white pollinose, while in *peromysci* all the abdominal segments bear pollen on the dorsal as well as on the lateral areas. The pubescence on the abdomen of *fontinella* is slightly shorter than that on *peromysci.* The legs of *fontinella* are sparsely invested with pollen and lack a band of white hairs on the outside of the anterior femora. There is no cluster of black hairs on the pleura of *fontinella.* The pubescence on the parafacials, parafrontals, face, and frontal vitta of *peromysci* is entirely black while that on the same areas of *fontinella* has several white hairs intermixed.

C. peromysci is definitely distinguished from the holotype (male) of *fasciata* Swenk by the following characteristics: *C. fasciata* significantly more massive than *peromysci.* Pollen absent on the antennæ of *fasciata,* present only on the extreme lower part of the head below the eyes, not extending up the para-

* The writer desires to express his appreciation to Mrs. Myron H. Swenk for permitting him to examine the cuterebrid collection of the late Professor Myron H. Swenk.

facials as in *peromysci.* Pubescence on the parafrontals, parafacials, and frontal vitta of *fasciata* composed mainly of black hairs interspersed with many white ones. Facial depression of *fasciata* not circumscribed below but prolonged into a shiny, brown, elevated area. No pollinose area near the dorsal limit of the ptilinal suture nor any contiguous with the eye between the facial depression and the vertex. Cheek grooves shallow. Outer ocellar triangle not raised as in *peromysci.* No black shiny spot on the lower margin of the eye nor between it and the mouth. Hair on the pleura noticeably shorter than on *peromysci,* no cluster of black hairs on the mesopleuron. Pollen clothing only the fifth abdominal segment and completely encircling it. Lateral margins of the fourth and fifth abdominal tergites without long white hairs.

Type in collection of author. Reared from larva taken by author from *Peromyscus leucopus noveboracensis,* October, 1940, at Ames, Iowa. Adult emerged June 1, 1941.

FIRST INSTAR LARVA.

Length, 4.2 mm.; width, 3.2 mm. Body tapering toward anterior end; anal segment blunt. Twelve segments visible; transverse band of spines on anterior margins of all but first segment, barely discernible on third and fourth segments. Bands wider on ventral surface, with more spines and more rows per band than on dorsal surface. Segments 2 and 5 with narrow bands of spines. Segments 6–12 with bands of about equal width; these bands wider than those on second and fifth segments.

Spines of segments 2, 5, and 6 all pointing posteriorly; other clearly visible bands composed of both anteriorly and posteriorly directed spines, the spines composing front of band directed anteriorly, those of rear portion of band directed posteriorly.

Caudal extremity of maggot ending in a single flat lobe, strongly emarginated, projecting beyond spiracles. Posterior spiracular plate on depressed portion of twelfth segment; each spiracle ending in two slits similar to those of second instar.

Above description based on one specimen taken from a cyst located just anterior to scrotum of host. Larva examined without clearing or mounting. Six other cysts in same mouse mostly around inguinal area.

SECOND INSTAR LARVA.

Body white, elongate; average length, 9.5 mm., greatest width, 3 mm. Segments covered with noncontiguous, flattended scales, some spinose.

Apparent head segment actually two, the cephalic segment very small. Spines ventral to mouth fitting into fold at junction between first and second segments. A number of small spines grouped dorsally on median part of first segment. A dorsal row of spines on each side of second segment extending anteriorly, curving over front of segment 2, then passing ventrally on each side of segment 1.

Segments 3–12 clothed with dark, sharp, single-pointed spines. Anterior margins of segments 3–12 with bands of posteriorly directed spines, the number of spines in each band increasing posteriorly until eighth segment, then decreasing. Spines of anterior row of each band broad; length and width gradually decreasing toward posterior rows of each band. Segment 5 bearing 4 dorsal spines in transverse row near middle of segment. Segment 3 with 3 ventral spines in medial row. Segment 10 bearing on venter 2 groups, each composed of 7–8 small spines, antero-laterad to middle, and interspersed with other spines of segment.

Segments 5–11 also bearing anteriorly directed spines on dorsal surface; segments 8–11 with similar spines on ventral surface. Segment 5 with row of 8 dorsal spines anteriorly directed on median part of posterior border. Dorsa of segments 6–11 with 1–4 rows of anteriorly directed spines on posterior borders. On ventral surface 1–3 rows of anteriorly directed spines on posterior margins of segments 8–10; 5–8 rows on venter of segment 11, increasing to 9–10 rows on the lateral area. Segment 12 well armed with anteriorly directed spines radiating at all angles and completely encircling segment.

Twelfth segment truncate with rounded anal lobe on each side of anus. Posterior spiracles on plates at apex of twelfth segment; each spiracle composed of two slits, the inner one rather straight; the outer one, somewhat serpentine, may be divided into two separate divisions. Spiracular slits lined with small hairs. Length and width of each spiracular plate, 0.12 mm. and 0.18 mm., respectively. Anterior spiracles internal, seen as inconspicuous openings on each side and at base of segment 2.

Cephalo-pharyngeal mechanism shown on Plate III. Length of cephalo-pharyngeal mechanism, 1.1 mm.

Description of second instar larva made from observation of 4 larvæ, 2 dissected and prepared on slides, the others examined in alcohol.

THIRD INSTAR LARVA.

Length of mature larva, 20–25 mm.; width, 7.5–7.8 mm., widest between sixth and eighth segments, tapering toward both ends; weight, 0.83–0.98 gm. Larva coriaceous with imbricated, hollow, tubercled spines arming segments. Spines light in color on immature larvae, dark brown on mature ones.

Head segment small, generally partially retracted. Oral hooks usually protruding from ventrally located mouth opening. Two large anterior lobes with small sensory tubercles separated from each other by median longitudinal furrow. Several rows of small, single-tubercled to 4-tubercled spines fitting into ventral groove-like structure between first and second segments. Some spines on second segment flattened and scale-like, others on segment 2 pointing posteriorly.

Number of rows of spines on segments 3–9 increasing posteriorly, decreasing slightly on segments 10 and 11. Rounded elevations bearing sensory tubercles at irregular intervals among spines. Spines on posterior portion of segments 3–11 pointing anteriorly, mostly single, few multifid. Spines of middle region of each segment flattened and scale-like, any tubercles present facing upward. First 4–6 rows of spines on each segment retrorse, many multifid. Multifid condition occurring mainly on the anterior 2 rows of spines of each segment, the number of tubercles decreasing in posterior rows. Some trifid and 4-tubercled spines found on third, fourth, and fifth rows of spines of each segment. Few simple spines on twelfth segment. Largest spines 0.36–0.41 mm. from base to apex; width at base, 0.25–0.30 mm.

Openings to anterior spiracles on each side near base of second segment, 0.98 mm. long, 0.4 mm. wide. Spiracles everted during formation of puparium. Posterior spiracular plates occupying central part of twelfth segment, kidney-shaped, 0.91 mm. long,

0.33 mm. wide, each perforated by three markedly sinuous slits, lined on entire periphery with fine hairs which might act as filters. Plates darker and division between them less distinct in mature larva. Twelfth segment retracted in preserved specimens, lighter in color than rest of integument. Large round anal lobe on each side of anal opening.

Paired mandibular sclerites exposed anteriorly and ventrally at extreme anterior part of cephalo-pharyngeal mechanism; sclerites curving ventrally within thoracic segments and tapering toward ventral articulations for the muscles moving hooks. Paired dentate sclerites articulating with bases of mandibular sclerites. Hypostomal sclerites articulating with dentate sclerites anteriorly and with pharyngeal sclerites posteriorly. Transverse bridge crossing hypostomal sclerites on ventral side; a small foramen through middle of hypostomal bridge. Pharyngeal sclerites divided into paired dorsal and ventral cornua. Entire cephalo-pharyngeal mechanism 2.5 mm. long. Paired chitinous structure of unknown function lying parallel and ventral to mandibular hooks.

Above description made from examination of 16 larvæ just before pupation. Several were cleared, the various parts mounted; others examined in alcohol. The usual method of treating the integument with KOH until sufficiently bleached removed tubercled spines, only flattened scales remaining. Leaving the integument in KOH for a relatively short time, dehydrating, then clearing in glycerin and mounting in glycerin jelly obviated this difficulty.

PUPARIUM.

Puparium black, consisting of dried and much hardened larval skin.

Average length, width, and weight determined from 14 puparia, 19 mm., 9.1 mm., and 0.73 gm., respectively. Distinct loss of weight evident in formation of puparium from third instar larva; a more spherical shape also assumed, probably preventing excessive loss of water during winter.

Stouter in middle and posterior, widest at seventh and eighth segments. Ten segments distinctly visible, the cephalic and spiracular segments retracted so that they are not seen. At fold

between segments 2 and 3, two light brown, column-like tubercles project from the integument which are the everted anterior spiracles of third instar larva. Entire puparium clothed with imbricated spines displaying tuberculation as in third instar larva.

During emergence of fly, the dorsa of the first 5 segments detach perfectly in single piece or cap. Puparium lined with thin, white, silken membrane.

PLATE III

Upper: Lateral view of right half of cephalo-pharyngeal mechanism of third instar larva of *Cuterebra peromysci;* dc, dorsal cornu; vc, ventral cornu; h, hypostomal sclerite; da, dorsal arch; d, dentate sclerite; m, mandibular hook; natural length, 2.5 mm.

Lower: Left—Group of three spines from second instar larva; greatly enlarged. Right—Group of spines from third instar larva, showing multifid spines and flattened scale; greatly enlarged.

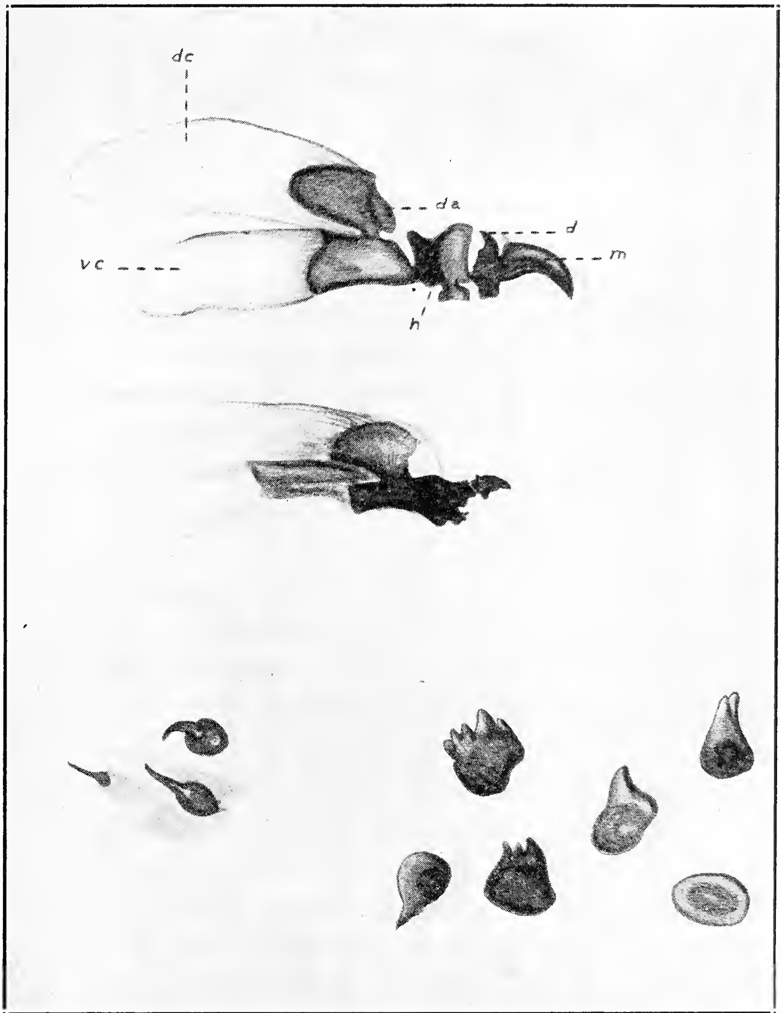
dc
da
d
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PLATE IV

Anterior view of head segments of third instar larva; A. sp, anterior spiracle; an. pr, antennal prominence; g, cephalic or first segment; st, sensory tubercle; sh, sheath over mandibular hook; mu. s, multifid spines; m, mandibular hook; greatly enlarged.

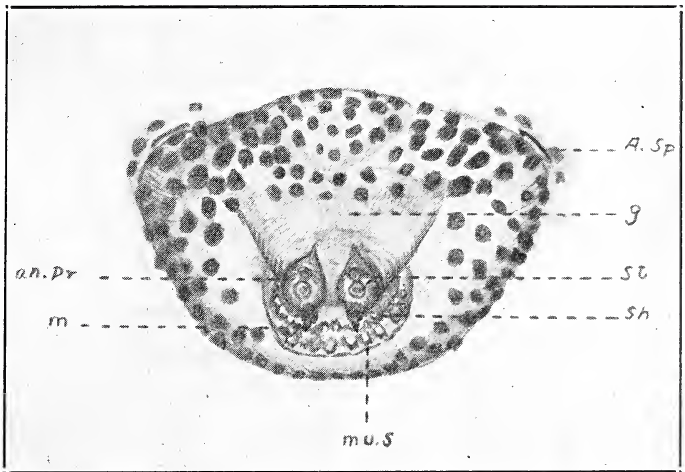
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PLATE V

Upper: Cephalic segments of third instar larva viewed from within; hb, hypostomal bridge; h, hypostomal sclerite; tr, trachea; a. sp, anterior spiracle; vc, ventral cornu; dc, dorsal cornu; f, second segment; g, first segment; an. pr, antennal prominence; m, mandibular hook; greatly enlarged.

Lower: Chitinous structure of unknown function found beneath the mandibular hooks, lying parallel to them; greatly enlarged.

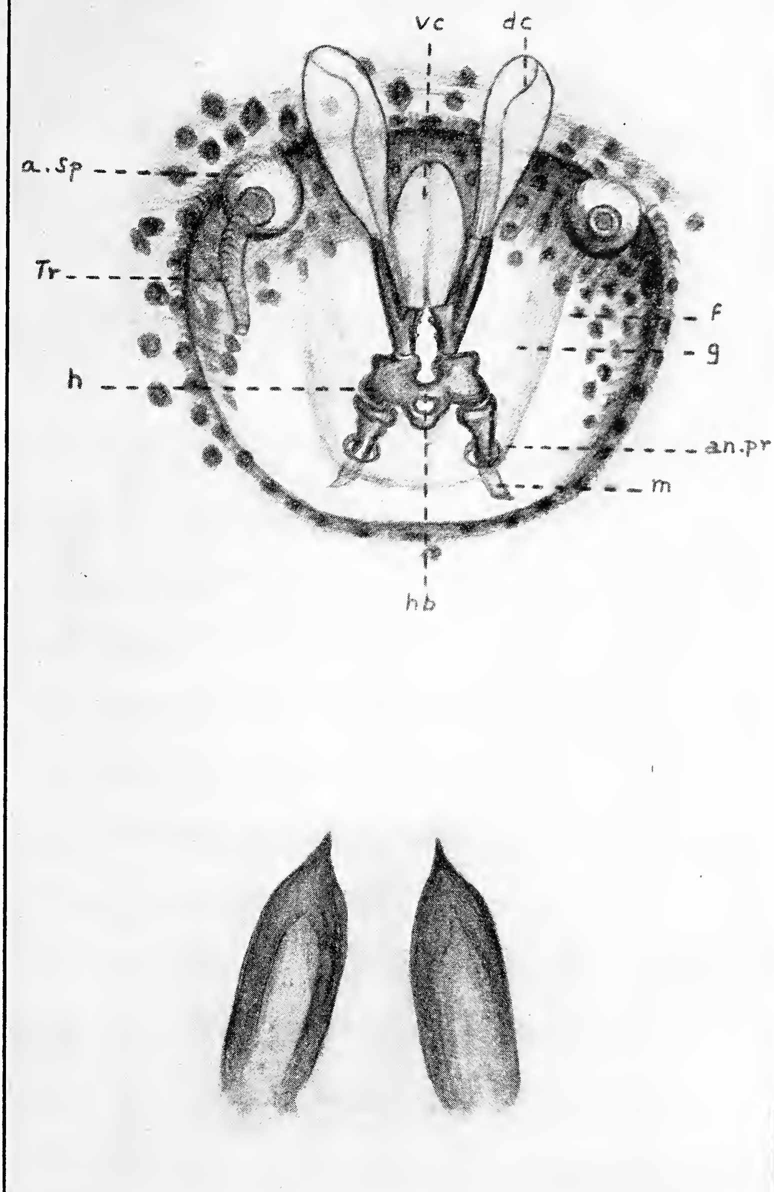
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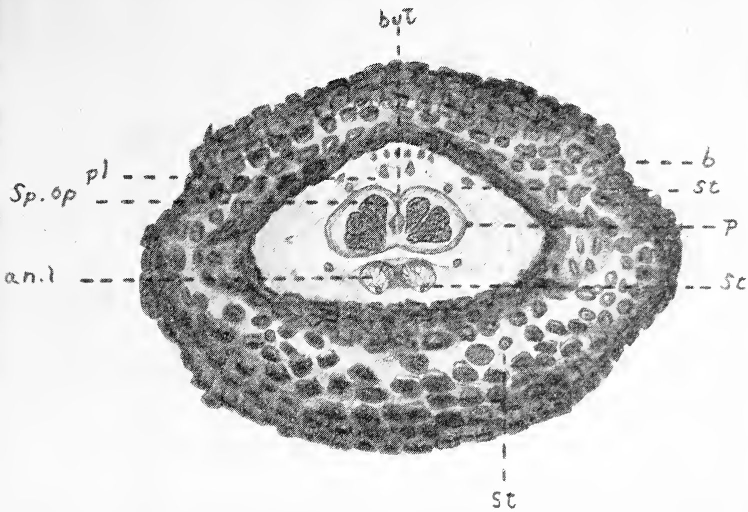
PLATE VI

Upper: Posterior view of eleventh and twelfth segments of third instar larva, showing the posterior spiracular plates and the spiracles; st, sensory tubercle; p, peritreme; b, eleventh segment; but, button; pl, twelfth segment; sp. op, spiracular opening; an. 1, anal lobe; greatly enlarged.

Lower: Posterior view of twelfth segment of second instar larva, showing posterior spiracular plates and the spiracles; note that left spiracle is divided into three external apertures while the right is divided into only two; openings lined with hairs as in third instar; same parts as for above; greatly enlarged.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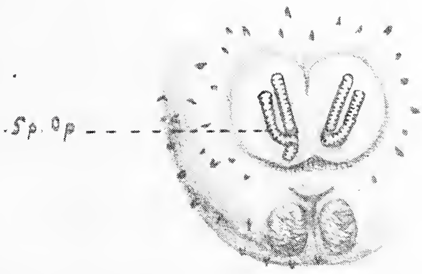

Sp. op

SIX NEW CHINESE MEMBRACIDÆ

BY W. D. FUNKHOUSER

Despite the unfavorable conditions for scientific work which now exist in China, the writer has continued to receive material from collectors in that country during the past two years.

This material has yielded six new species of Membracidæ which are here described and figured as follows:

1. **Tricentrus obesus** sp. nov. (Fig. 1).

Large, robust, heavy-bodied, black, punctate, pubescent; suprahumerals heavy, curved, extending outward and upward; posterior process short, heavy, blunt, tectiform; tegmina uniformly bronze-brown with a white band showing through basal third; undersurface black.

Technical description:

Head subquadrate, wider than long, black, finely punctate, short golden pubescence; base elevated and sinuate; eyes mottled brown and gray; ocelli small, pearly, inconspicuous, equidistant from each other and from the eyes and situated slightly above a line drawn through centers of eyes; inferior margins of genae rounded; clypeus twice as long as broad with a weak lobe on each side at base, extending for half its length below inferior margins of genæ, tip broadly truncate.

Pronotum black, finely punctate, sparingly pubescent with short golden hairs; metopidium broader than high, almost vertical above the head; median carina strongly percurrent; humeral angles heavy, triangular and blunt; suprahumeral horns heavy, swollen, about as long as the distance between their bases, extending outward and upward, anterior margins curved, tips blunt; posterior process short, heavy, tricarinate, tectiform, tip blunt and extending just to internal angles of tegmina; scutellum well exposed on each side.

Tegmina dark bronze-brown; base coriaceous, punctate and pubescent; a broad white patch just posterior to the coriaceous portion showing through a hyaline area; tips blunt; apical limbus very narrow; five apical and two discoidal cells.

Undersurface of body black; legs simple, femora black, tibiæ dark brown, tarsi light brown; posterior trochanters armed with teeth.

Length from front of head to tips of tegmina 7.6 mm.; width between tips of suprahumerals 5.2 mm.

Type: female.

Described from five specimens, all females, one collected at Wong Sa Shui, S. Klangai, on July 8, 1936, three from Liung-

Chon San, S. W. Funien, taken July 21, 1936, and one from Kwangtung collected July 13, 1934. Type and four paratypes in author's collection.

This species resembles *T. samai* Funkh., another Chinese species, but is larger and differs in the size and shape of the suprahumerals.

2. **Tricentrus purpureus** sp. nov. (Fig. 2).

Large, robust, purplish-black, punctate, pubescent; suprahumerals short, blunt, extending directly outward; posterior process heavy, acute, extending just beyond internal angles of tegmina; tegmina bronze-hyaline with base opaque black and punctate and with a large white spot just behind the base; undersurface black.

Technical description:

Head subquadrate, twice as broad as high, purplish-black, finely punctate, densely pubescent; base weakly arcuate; eyes reddish; ocelli large, amber-colored, equidistant from each other and from the eyes and situated well above a line drawn through centers of eyes; inferior margins of genæ sinuate, flanged and projecting slightly cephalad; clypeus extending for half its length below inferior margins of genae, tip blunt and rounded.

Pronotum purplish-black, coarsely punctate, sparingly pubescent; metopidium broader than high, almost vertical above the head; median carina faintly percurrent; suprahumeral horns short, blunt, triquerate, about one-fourth as long as the distance between their bases, extending directly outward; posterior process heavy, tectiform, tricarinate, tip acute and reaching to a point just beyond internal angles of tegmina; scutellum well exposed on each side.

Tegmina bronze-hyaline; veins strong; base opaque, coriaceous and punctate; a large white spot showing through tegmina just behind coriaceous base; apical limbus broad; five apical and two discoidal cells.

Undersurface black; legs simple; femora, tibiæ and tarsi black; hind trochanters armed with spines.

Length from front of head to tips of tegmina 8 mm.; width between tips of suprahumerals 4.7 mm.

Type: female.

Described from a single specimen taken on Cheung-chow Island near Hong Kong on May 9, 1940 by F. KoTo. Type in author's collection.

This species is near *T. fulgidus* Funkh., but differs in being dull and punctate instead of smooth and shining.

3. **Tricentrus taurus** sp. nov. (Fig. 3).

Small, brown, punctate, very sparingly pubescent; suprahumerals small, sharp, spike-like, extending forward and outward; posterior process heavy,

weakly sinuate, tectiform, acuminate, extending well beyond internal angles of tegmina; tegmina uniformly light brown, wrinkled, translucent; undersurface brown.

Technical description:

Head subquadrate, roughly sculptured, black, finely punctate, sparingly pubescent with short golden hairs; base highly arcuate and weakly sinuate; eyes mottled light brown and dark brown; ocelli amber-colored, a little farther from each other than from the eyes and situated well above a line drawn through centers of eyes; inferior margins of genæ rounded; clypeus extending for half its length below inferior margins of genæ, tip rounded and pilose.

Pronotum golden brown, finely punctate, weakly pubescent; metopidium broader than high, a large black callosity above each eye; median carina weakly percurrent; humeral angles large, triangular and blunt; suprahumeral horns small, spike-like, triquerate, about as long as the distance between their bases, extending outward and forward, tips sharp; posterior process robust, tectiform, slightly arcuate above dorsal line of pronotum, tip acuminate and extending well beyond internal angles of tegmina; scutellum widely exposed on each side.

Tegmina light brown, wrinkled, translucent; base narrowly opaque, coriaceous, punctate and pubescent; veins weak; apical limbus narrow; five apical and two discoidal cells.

Undersurface of body brown; legs simple; femora, tibiæ and tarsi light brown; tibiæ pilose; hind trochanters bearing small teeth on inner surface.

Length from front of head to tips of tegmina 4.8 mm.; width between tips of suprahumerals 3.5 mm.

Type: female.

Described from a single specimen collected by Mr. L. Gressitt on July 27, 1938 at Gang-kou, Southwest Fuklen in South China. Type in author's collection.

4. **Gargara nodulata** sp. nov. (Fig. 4).

Small, black, punctate, pubescent; eyes white; posterior process short and strongly sinuate; tegmina hyaline with bases broadly black, a brown band before apex and with the veins decorated with large nodules; undersurface black; legs brown.

Technical description:

Head subquadrate, black, shining, finely punctate, sparingly pubescent; base highly sinuate and arcuate; eyes white, transparent; ocelli amber-colored, twice as far from each other as from the eyes and situated well above a line drawn through centers of eyes: inferior margins of genæ straight; clypeus broad, extending for half its length below inferior margins of genæ, tip broadly rounded.

Pronotum black, finely punctate, weakly pubescent; metopidium broader than high, sloping above the head; humeral angles large, blunt, triangular;

no suprahumerals; median carina faintly percurrent; posterior process short, heavy, blunt, strongly sinuate, not reaching the apical angles of tegmina; scutellum well exposed on each side.

Tegmina hyaline; base broadly opaque, black and punctate; a brown transverse band before apex; veins bearing large tubercular nodules; apical limbus well developed; five apical and two discoidal cells.

Undersurface of body black; legs uniformly brown; hind trochanters unarmed.

Length from front of head to tips of tegmina 3.6 mm.; width between humeral angles 1.8 mm.

Type: male.

Described from two males, both collected by L. Gressitt at Taiyong, East Kwantung, China, on August 5, 1936. Type and paratype in author's collection.

The tegmina of this species are similar to those of *G. nodipennis* Funkh., but the insects are entirely different in the size and shape of the pronotum.

5. **Gargara gressitti** (Fig. 5).

Brown, punctate, pubescent; eyes yellow; posterior process strong, arcuate, tectiform, reaching just to internal angles of tegmina; tegmina uniformly clouded hyaline with base narrowly brown and punctate; undersurface and legs brown.

Technical description:

Head subquadrate, black, punctate, pubescent; base highly arcuate and weakly sinuate; eyes yellow; ocelli pearly, a little farther from each other than from the eyes and situated slightly above a line drawn through centers of eyes; inferior margins of genæ rounded; clypeus broad, deflexed, extending for half its length below inferior margins of genæ, tip rounded and pilose.

Pronotum brown, finely punctate, sparingly pubescent with short golden hairs; metopidium broader than high, nearly vertical above the head, much darker in color next to the head, black lateral callosities above eyes; humeral angles broad, triangular, blunt; median carina strongly percurrent; no suprahumerals; posterior process heavy, tectiform, tricarinate, tip acute and just reaching internal angles of tegmina; scutellum well exposed on each side.

Tegmina uniformly clouded hyaline; base narrowly brown, coriaceous and punctate; veins strongly pilose; apical limbus narrow; five apical and two discoidal cells.

Undersurface of body dark brown; legs simple, light brown; hind trochanters unarmed.

Length from front of head to tips of tegmina 5.3 mm.; width between humeral angles 2.5 mm.

Type: female.

Described from a single specimen collected at Hong San, Southeast Kiangai, China, by Mr. L. Gressitt on July 25, 1936. Type in author's collection.

6. **Gargara tonkini** sp. nov. (Fig. 6).

Very small; head black; pronotum golden brown, punctate, pubescent; eyes yellow; posterior process slender, triquerate, extending just to internal angles of tegmina; tegmina hyaline, base narrowly brown and coriaceous, a brown transverse band across middle, veins white; undersurface of body dark brown; legs light brown.

Technical description:

Head subquadrate, black, finely punctate, densely pubescent with golden hairs; base weakly arcuate and sinuate; eyes yellow; ocelli large, pearly, conspicuous, farther from each other than from the eyes and situated well above a line drawn through centers of eyes; inferior margins of genæ rounded; clypeus broad, black, extending for half its length below inferior margins of genæ, tip rounded and pilose.

Pronotum bright golden brown, finely punctate, pubescent with long golden hairs; metopidium broader than high, rounded above the head, uniformly golden brown; humeral angles heavy, triangular, blunt; no suprahumerals; median carina obsolete; posterior process slender, triquerate, tectiform, concolorous brown, tip sharp and just reaching internal angles of tegmina; scutellum broadly exposed on each side.

Tegmina hyaline; base narrowly brown, coriaceous and punctate; a brown transverse fascia across middle; veins strong, white and sparingly pilose; apical limbus narrow; five apical and two discoidal cells.

Sides of thorax and undersurface of body dark brown; legs simple, light brown; hind trochanters unarmed.

Length from front of head to tips of tegmina 3.5 mm.; width between humeral angles 1.8 mm.

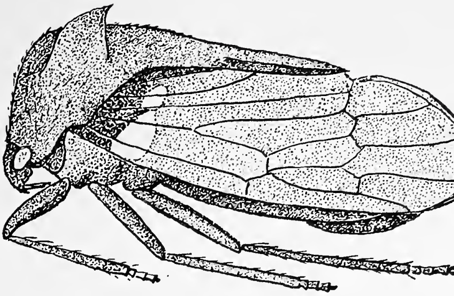
Type: female.

Described from two specimens, both females and both taken at Tonkin, Indo-China, in 1937 by A. de Cooman. Type and paratype in author's collection.

This species is close to *G. flavipes* Funkh., a small black form also from southern China and Indo-China.

PLATE VII

Figure 1. *Tricentrus obesus* sp. nov.
Figure 2. *Tricentrus purpureus* sp. nov.
Figure 3. *Tricentrus taurus* sp. nov.
Figure 4. *Gargara nodulata* sp. nov.
Figure 5. *Gargara gressitti* sp. nov.
Figure 6. *Gargara tonkini* sp. nov.



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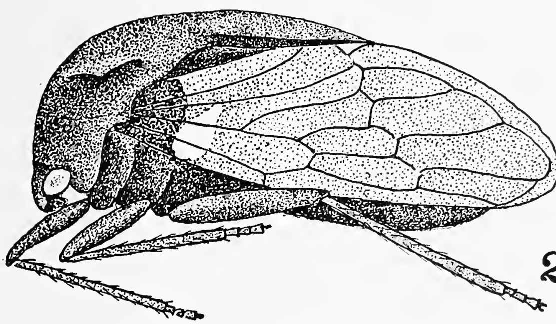

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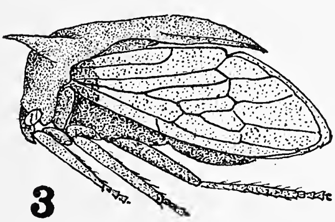

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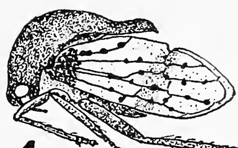

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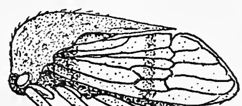

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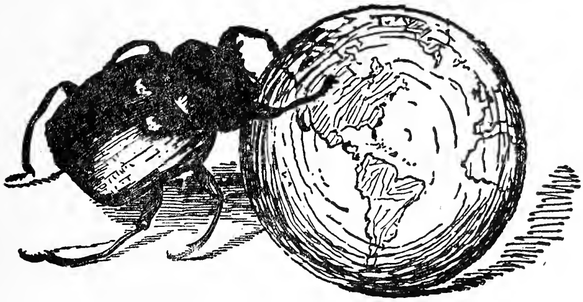

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NOTES ON ECUADORIAN BUTTERFLIES. II. PAPILIO*

BY F. MARTIN BROWN

COLORADO SPRINGS, COLORADO

Of the fifty-six species of this group of butterflies reported in Rothschild & Jordan (Nov. Zool., xiii, pp. 411–745, 1906) we have thirty-six and one other, not listed from Ecuador, in this monograph. At no time was collecting emphasis made upon the group. Since it has been a collector's favorite for so long we did not feel that we could spare the time from less well-known groups for such emphasis. Our collecting was restricted to a narrow east-west band across the Andes in the central part of the country. The material reported upon here represents in reality three field collections, one made by Wm. Clarke-Macintyre and Eugene Schilling at Balzapamba and Playas de Montalvo at the western foot of the Andes in April–June, 1938, our own collection made in the Pastaza and the Upano valleys during 1938 and 1939, and that of David Laddey made at Santo Domingo de los Colorados and Palmar on the Pacific slope in 1940–41.

The only references given in this paper are to Rothschild & Jordan's monograph which although thirty-five years old is still the standard work on South American *Papilio*.

When this paper was completed I sent it to Mr. R. C. Williams of Philadelphia for criticism in light of the Coxey collection at the Academy of Natural Sciences. Mr. Williams very kindly

* Part I appeared in the Annals Ent. Soc. Amer., xxxiv, p. 432–436, 1941.

sent me considerable information which I have incorporated with my own notes. All references in the following discussions relative to material in the Academy collections are based on Mr. Williams' comments. I am grateful to him for these. This information has not been incorporated in the table at the close of the paper. It would not affect it in any major way.

17. **P. pizzaro** Staudinger (p. 452). I took two females at Puyo, 1000 m., Napo-Pastaza 3, 7.xii.38, that are apparently of this species. They are clearly neither *chabrias* Hewitson, *bolivar* Hewitson nor *cutorina* Staudinger, species that might be expected and whose females are similar. If these are *pizzaro* the species ranges to the eastern foothills of the Andes in Ecuador.

20f. **P. æneas bolivar** Hewitson (p. 457). In the Academy of Natural Sciences at Philadelphia (A.N.S.P.) there are 2 ♂♂, 2 ♀♀ from Mera, Napo-Pastaza (*Coxey*); 1 ♂ La Merced, Tungurahua (*Coxey*), and 4 ♂♂ 1 ♀ below Macas, Santiago-Zamora (*Feyer*).

23c. **P. sesostris** Cramer (p. 461–2). Although the nymotypical race is not recorded in R. & J. from Ecuador we took specimens at Puyo, 1000 m., Napo-Pastaza, 14.xii.38, and on the Rio Tutenongoza, near Sucua, 900 m., Santiago-Zamora, 10.ii.39, and Macintyre has sent us a male from the Rio Jondachi near Archidona, 800 m. collected by the Olallas in November, 1939. Neither of the west slope parties turned up race *tarquinius* Bdv. Perhaps it does not fly south so far as central west Ecuador. R. & J. record it only from the northwestern part. In the A.N.S.P. there are 1 ♂, 1 ♀ from Mera, Napo-Pastaza; 7 ♂♂, 1 ♀ La Merced, Tungurahua, and 2 ♂♂ Hda. La Mascota, Napo-Pastaza, collected by Coxey, and 4 ♂♂ 1 ♀ below Macas, and 1 ♂ Macas, Santiago-Zamora, collected by Feyer.

24b. **P. childrenæ œdippus** Lucas. (p. 463). A single specimen was taken at Sucua, 900 m., Santiago-Zamora, 6.ii.39. This is considerably to the south of any previous record. The specimen lacks the light subapical spot on the forewing and the red on the hindwing is restricted to a brilliant dash between Cu_1 and Cu_2. There is a faint, small, rose-pink spot in the same space on the underside. The upperside is not unlike *P. sesostris zestos* but differs from that Central American insect in having the green patch on the forewing extend into the cell. Another male was

taken by Laddey at Palmar, 200 m., Manabi, 4.iv.41. On this specimen, which like the first mentioned lacks the light spot on the forewing, the red marking on the hindwing is large and bold and the cell of the forewing is almost completely filled with green scales. There is a large red spot on the underside of the hindwing in this second specimen. It is possible that the east slope material is true *œdippus* and that the west slope material is worthy of a distinct name. This will only be shown by much more collecting on the west slope.

25a. **P. erlaces lacydes** Hewitson (p. 464). This is a very common and rather variable form in the valley of the Rio Pastaza through the eastern foothills of the Cordillera Oriental. We took 38 ♂♂ and 4 ♀♀ in this region and only 3 ♂♂ and 1 ♀ out of it. It was taken in practically every month of the year. Wet season specimens bear a greener patch on the forewings than do the dry season specimens. The number, size and shade of the red spots on the hindwing vary somewhat. The species seems to range from 1800 m., to 1000 m., in the humid forest. It is not found in the semi-arid region around Baños at 1800 m. One female and one male were taken at Puyo, in the Amazonian plain and two males were taken just out of the foothill region on the west bank of the Rio Upano, one at Sucua and one near Macas. None of our specimens has even a trace of a white spot on the forewing. The specimen from Ambato in Oberthür's collection noted by R. & J. is obviously from much lower down the Rio Pastaza. In the A.N.S.P. there are 2 ♂♂, 1 ♀ from La Merced, Tungurahua, and 32 ♂♂, 12 ♀♀ from Hda. Mascota collected by Coxey and 1 ♂, 1 ♀ from Macas collected by Feyer.

27. **P. drucei** Butler (p. 466). We took only two specimens of this species at Puyo, 1000 m., Napo-Pastaza, 12.xii.38. In the A.N.S.P. there are 1 ♀ from La Merced, Tungurahua, and 3 ♀♀ from Mera, Napo-Pastaza, collected by Coxey and a male from Hda. La Zatayacu, Rio Anzu, 600 m., Napo-Pastaza (*Macintyre*). Macintyre has sent me a pair from Huagra-yacu, 900 m., Napo-Pastaza, 14.iii–12.v.41.

30c. **P. vertumnus bogotanus** Felder (p. 470). We did not take this species. Coxey took a male at the Hda. La Mascota, Napo-

Pastaza, and 2 ♂♂ at La Merced, Tungurahua. These were determined by Schaus. They are in the collection of the A.N.S.P.

31c. **P. lycimenes paralius** Rothschild & Jordan (p. 474). This species is represented by 3 ♂♂ from Balzapamba, 700 m., Bolivar, iv.38, and 3 ♀♀ from Playas de Juan Montalvo, 30 m., Los Rios, 15.iv.38., taken by Macintyre and Schilling, and 1 ♂, 2 ♀♀ taken at Palmar, 200 m., Manabi, by David Laddey in April & May, 1941. In the A.N.S.P. there are 15 ♂♂, 6 ♀♀ from Naranjapata, 4 ♂♂, 6 ♀♀ from Dos Puentes, and 1 ♂ from Hda. Cutuguay, collected by Coxey; a pair from Huigra (*Rhoads*) and a female from Balzapamba.

34d. **P. iphidamus calogyna** Rothschild & Jordan (p. 481). Macintyre and Schilling collected a fine series of this race at Balzapamba; 11 ♂♂, 17 ♀♀ were taken in May and June, 1938, and 2 ♂♂, 1 ♀ were taken by them in April, 1938, at Playas de Juan Montalvo. Laddey took 2 ♂♂ and 2 ♀♀ near Santo Domingo de los Colorados, 500–550 m., Pichincha, in January and February, and 2 ♂♂, 3 ♀♀ at Palmar, 200 m., Manabi, in April & May, 1941. I am not at all certain that I have correctly identified all the Balzapamba females. I took a female at Puyo, 1000 m., Napo-Pastaza, 11.xii.38, that seems in no way to differ from the *calogyna* I have from the west slope. If my determination is correct this is the first record of the species east of the Andes in Ecuador. In Colombia the race *phalias* R. & J. has been taken on the slopes east of Bogata. The females of these two races are very difficult to separate and without eastern Ecuadorian males I hesitate to include the race *phalias* R. & J. as the eastern form in Ecuador.

40. **P. lysander** Cramer (p. 492). We took three males at Puyo, 1000 m., Napo-Pastaza, on December 5 and 6, 1938. There are 2 ♂♂ from Hda. La Mascota, Napo-Pastaza (*Coxey*), in the A.N.S.P. Macintyre took 4 ♂♂, 3 ♀♀ at Huagra-yacu, 900 m., Napo-Pastaza, between 14.iii and 12.v.41.

45a. **P. timias timias** Doubleday (p. 507). Macintyre and Schilling took 10 ♂♂ and 2 ♀♀ at Playas de Juan Montalvo, 30 m., Los Rios, in April, 1938. Laddey took a ♂ and a ♀ at Santo Domingo de las Colorados, Pichincha, 550 m., 12.xii.40. Race *potone* R. & J. is more probably a northern race than an altitude race. The record for this latter race from Ambato given in

R. & J. needs verification; I doubt it very much. In the collection of the A.N.S.P. are 6 ♂♂, 1 ♀ Naranjapata, and 15 ♂♂, 16 ♀♀ from Dos Puentes collected by Coxey and a male taken by Rhoads at Huigra.

51f. **P. polydamus polydamus** Linné (p. 520). Six specimens of this common species are in our Ecuadorian collections. 1 ♂, 2 ♀♀ were taken at Playas de Juan Montalvo, Los Rios, in March and April, 1938, by Macintyre and Schilling, another male was taken at Palmar, 200 m., Manabi, by Laddey on May 19, 1941, and two hail from the Amazonian slope, 1 ♂ from Abitagua, Napo-Pastaza, 1300 m., Jan., 1937, taken by Macintyre and 1 ♂ from Puyo, 1000 m., Napo-Pastaza, 7.xii.38, which Mrs. Brown captured. The east slope specimens differ from those from the west slope in a minor fashion. The limbal row of spots on the west slope specimens is bronzy while these spots on the hindwing of the east slope specimens is pale green. These rows are closer to the margin of the wings in the east slope specimens than in those from the west slope. The series is entirely inadequate to make a real comparison between east and west slope forms. Coxey collected a female at La Merced, Tungurahua (A.N.S.P.).

52. **P. philetas** Hewitson (p. 524). This common species is represented by ten specimens from the upper part of the rain forest in the valley of the Rio Pastaza. They were all taken by Macintyre's native collectors during August and September, 1938, at Yungilla on the Rio Blanco, a tributary of the Pastaza at 1800 m., a few miles east of Baños and out of the semi-arid area. In the A.N.S.P.. there are 11 ♂♂, 3 ♀♀ from La Merced, Tungurahua, and a male from Yungilla, Tungurahua, collected by Coxey, and 3 ♂♂, 2 ♀♀ from Macas (*Feyer*).

56b. **P. belus varus** Kollar (p. 529). 7 ♂♂ were taken in the Amazonian plain near the foothills. Four of these were captured by Macintyre at Jatunyacu, 700 m., Napo-Pastaza, in March, 1937; two at Puyo by the Browns, 7 and 15.xii.38, and one was purchased from the Olsons, missionaries at Sucua, Santiago-Zamora on the Rio Upano. Recently Macintyre sent me a male from Huagra-yacu, 900 m., 19.iii.41, two more from Bomboini-yacu, 900 m., and a fourth from the headwaters of the Rio Ara-

juno, 1000 m., 30.iv.41. All these stations are north of Mera and southeast of the Rio Anzu.

59. **P. crassus** Cramer (p. 536–7). In a recent shipment from Macintyre there were two males of the form *crassus* differing from Rothschild and Jordon's description in that the light scales on the forewing are old gold, not "yellowish creamy." These were taken at Huagra-yacu, 900 m., 9.iv.41, and Bomboini-yacu, 900 m., 10.v.41. Both stations are in the province of Napo-Pastaza.

60a. **P. ajax americus** Kollar (p. 541). I diverge from Rothschild & Jordan in calling this species *ajax*. They note that this name has priority but prefer the then more familiar *polyxenes*. This race is abundant in the cultivated valleys of the temperate parts of Ecuador. We took it as far east on the Pastaza as Rio Verde, Tungurahua, at 1400 m., in the drier part of the subtropical region. It is quite variable. Its early stages were described by Brown in *Bull. So. Calif. Acad. Sci.*, XXXVIII, 200–201, 1939. Some ninety bred specimens have been loaned to Chermock and are being studied along with the other races. Coxey collected this species at La Merced and Yungilla in Tungurahua and also at Hda. La Mascota, Napo-Pastaza. This last station is much further east than we took it. Coxey's 7 ♂♂ and 1 ♀ from that station leaves no doubt that this essentially temperate species will and does penetrate the tropics when its foodplant is available—cultivated white carrot, "zanohria blanca," in this case. 28 ♂♂ and 10 ♀♀ in the collection of the A.N.S.P. came from the above three stations.

66d. **P. thoas neacles** Rothschild & Jordan (p. 553). Laddey has sent me a single ♂ of this race from Santo Domingo de los Colorados, 500 m., Pichincha, 1.i.41, and another from Palmar, 200 m., Manabi, 25.iv.41. The A.N.S.P. collection contains single males from Dos Puentes and Naranjapata, collected by Coxey.

66f. **P. thoas cinyras** Ménétries (p. 560). I have a male from Puyo, 1000 m., Napo-Pastaza, May, 1937, taken by Macintyre, and another from Archidona, 800 m., xi.39, collected by the Olallas. In the A.N.S.P. are 11 ♂♂ from La Merced, Tungurahua (*Coxey*), and a female from Napo, Napo-Pastaza (*Macintyre*). There is also a male from Bucay, on the western slope

in the territory of the preceding race. R. C. Williams states that *cinyras* is considered a distinct species in the collection of the A.N.S.P. and certainly its markings seem quite distinct from *thoas*.

69b. **P. pæon pæon** Boisduval (p. 567). Macintyre and Schilling took 3 ♂♂ at Balzapamba, 630 m., Bolivar, during May and June, 1938. Coxey took this species in the valley of the Chanchan at stations ranging from about 400 m. to 2100 m.—1 ♂, Dos Puentes, 6 ♂♂, Huigra, 1200 m., 3 ♂♂, Huigra, 2100 m. In addition to these the A.N.S.P. has a pair collected at Huigra by Rhoads.

77c. **P. lycophron phanias** Rothschild & Jordan (p. 575). We did not take this species. There is a female from Hda. Zatayacu, Rio Anzu, 600 m., Napo-Pastaza (*Macintyre*) in the A.N.S.P.

78b. **P. androgeus androgeus** Cramer (p. 579). Laddey took a male at Santo Domingo de los Colorados, 500 m., Pichincha, 2.i.41. I purchased a male at Sucua, 900 m., Santiago-Zamora, from the Olsons, missionaries stationed there who in the past have supplied some collectors with native collected material from that region. This specimen differs in several respects from the west slope specimen noted above. The specimen is larger, the dorsal streak on the abdomen much narrower, the spot in Sc_3–Sc_4 greatly reduced, the yellow discal band on the hindwings does not extend distally beyond the end of the cell and there is only a marginal row of crescentic areas of yellow scales on the hindwing. On the underside the dark limbal band, bearing the rows of burnt orange and bluish lunules, is much broader; the cell of the forewing and the marginal band much broader and darker. I am not sure whether or not to designate this Sucua specimen race *laodocus* Fabricius or not. R. & J. report the race *a. androgeus* from N.W. Ecuador but not from eastern Ecuador although they have seen specimens from eastern Peru. In the collections of the A.N.S.P. there are 1 ♂, Hda. La Mascota, Napo-Pastaza, 2 ♀♀, Mera, Napo-Pastaza, collected by Coxey, and a male from Hda. La Zatayacu, Rio Anzu, 600 m., Napo-Pastaza (*Macintyre*). These are determined as f. *feyeri* Niepelt of which Williams writes me "doesn't seem much different from typical *androgeus* from Peru, Paraguay, etc."

90. **P. epenetus** Hewitson (p. 604). Macintyre and Schilling collected 5 ♂♂ at Balzapamba, 630 m., Bolivar, May and June, 1938, and 1 ♂ at Playas de Montalvo, 30 m., Los Rios, March, 1938.

95b. **P. anchisiades anchisiades** Esper. (p. 608). Macintyre and Schilling took 2 ♂♂ and 1 ♀ on the west slope. The males from Balzapamba, 630 m., Bolivar, May, 1938, vary somewhat, one of them approaching race *idæus* Fabricius in some respects. This specimen also has a very slight tail, the other is typical of *anchisiades*. The female, taken at Playas de Juan Montalvo, 30 m., Los Rios, April, 1938, approaches those of *idæus* on the underside of the forewing. There are 4 ♂♂ 2 ♀♀ collected by Feyer below Macas on the Rio Upano, Santiago-Zamora, in the A.N.S.P. I have a lone specimen from the humid jungles at the east foot of the Andes collected by Macintyre at Huagra-yacu, 900 m., Napo-Pastaza, 16.iii.41.

96c. **P. isidorus flavescens** Oberthür (p. 611). I have three males of this form taken by Macintyre at Abitagua, 1300 m., Napo-Pastaza, in June, 1937. He also took at the same time a male that closely resembles race *brises* Rothschild & Jordan, and another in January of that year at the same station that is inseparable from *brises*. Since Rothschild & Jordan's race came from "Bogota" I suspect that these red-spotted *isidorus* did not come from the Rio Magdalena as they suggest, but from the eastern slope of the Andes in Colombia. If this is so these Abitagua specimens suggest that the Oberthür's race is dichromic and that *brises* should be considered a form of *flavescens* rather than a race. The small size of the spots on the upperside of the hindwing lead me to believe that these red-spotted specimens are not the nymotypical race which flies in the south in S. E. Peru and Bolivia. Three males recently received from Macintyre from Huagra-yacu, 900 m., Napo-Pastaza, taken between 19.iii and 1.iv.41 show exactly the same variation as do the Abitagua specimens. Two are typical *flavescens,* the other a *brises.*

102d. **P. torpuatus leptalea** Rothschild & Jordan (p. 620). Macintyre and Schilling took 2 ♂♂ on 26.v.38 & vi.38 at Balzapamba and 1 ♂ at Playas de Montalvo in April, 1938.

102e. **P. torquatus torquatus** Cramer (p. 620). I took a single male at Macas, 1050 m., Santiago-Zamora, 26.i.39.

105. **P. zagreus** Doubleday (p. 624). This is another species that I do not have. Feyer sent the A.N.S.P. 17 ♂♂ from below Macas on the Rio Upano and 2 ♂♂ from Macas, Santiago-Zamora.

107c. **P. bachus belsazar** Niepelt. The Coxey collection in the A.N.S.P. contains a female from Cusarci above Macas on the Rio Upano that Feyer collected. Macintyre told me of taking a specimen just outside of Puyo which he sent to Frank Johnson.

115. **P. aristeus bitias** Godart (p. 643). I took three specimens, all males, at scattered localities on the eastern slope of the Andes; Rio Blanco, nr. Baños, Tungurahua, 1800 m., 12.x.38, Rio Topo, Tungurahua, 1226 m., 28.ix.38, and Macas, Santiago-Zamora, 1050 m., 25.i.39. The obsolescents of the distal band on the upperside of the hindwing seems to increase with altitude.

119a. **P. warscewiczi jelskii** Oberthür (p. 650). The Coxey collection in the A.N.S.P. contains a male from Cusarci above Macas on the Rio Upano (*Feyer*).

120a. **P. cacicus cacicus** Lucas (p. 652). A single male has been received from Macintyre. It was taken at Abitagua, 1200 m., ix.15.37. It is quite probable that the specimen reported by R. & J. from Ambato came from lower down the Rio Pastaza. A male from Macas, Santiago-Zamora (*Feyer*), is in the A.N.S.P.

121. **P. euterpinus** Godman & Salvin (p. 653). Coxey took this rarity (1 ♂) at Hda. La Mascota, Napo-Pastaza. There is another male from Macas collected by Feyer also in the A.N.S.P. Macintyre has taken one or two specimens in the Pastaza Valley near the Topo. These are in Frank Johnson's collection.

125. **P. phaon** f. **phaon** Boisduval (p. 662). Laddey took a typical male at La Iorena, an hacienda about 15 km. east of Santo Domingo de los Colorados, Pichincha, 550 m.

126d. **P. euryleon hænschi** Rothschild & Jordan (p. 665). Macintyre and Schilling took 2 ♂♂ at Balzapamba, 630 m., Bolivar, in April and May, 1938. Laddey has sent me a male from La Lorena, Pichincha, 550 m., 1.iii.41, and a female from Santo Domingo de los Colorados, 500 m., Pichincha, 2.i.41. Coxey collected 7 ♂♂ at Dos Puentes and a pair at Naranjapata. These are

in the collections of the A.N.S.P. where *hænschi* is considered a good species and not a race of *euryleon.*

126e. **P. euryleon anatmus** Rothschild & Jordan (p. 666). Coxey took a male at Hda. La Mascota, Napo-Pastaza (*A.N.S.P.*). This is considered a full species at A.N.S.P.

128c. **P. harmodius xeniades** Hewitson (p. 668). This race is common in the valley of the Rio Pastaza from Rio Blanco to Rio Topo. We collected 36 ♂♂ and 1 ♀. All but one male were taken in September, 1938; an equal period of collecting in March, 1939, yielded that single male. Nine of the males (25 per cent) have the spots on the hindwing, except the anal spot, buff or orange instead of red. The white submarginal bars are present in one third of the specimens. Only one specimen shows a white center in any of the red spots. The female is form *virginia* Kirby. This is also given full specific rank in the collections of the A.N.S.P., where there are 10 ♂♂, 5 ♀♀, Hda. La Mascota, Napo-Pastaza, and 1 ♂, La Merced, Tungurahua, among Coxey's collection. A female from Macas collected by Feyer in that collection was determined as form *virginia* Kirby by Fox. Macintyre's last shipment contained three males from Huagra-yacu, 900 m., Napo-Pastaza, 14.iii–9.v.41. One of these has orange spots.

129. **P. trapeza** Rothschild & Jordan (p. 669). I took a single male at Rio Blanco, 1000 m., a tributary of the Rio Upano about a half day's walk south of Macas, 30.i.39. Coxey took a male at Hda. La Mascota, Napo-Pastaza (*A.N.S.P.*).

148e. **P. agesilaus autosilaus** Bates (p. 706). We took six specimens at Puyo, 1000 m., Napo-Pastaza, 11–15.xii.38, and one at Sucua, 900 m., Santiago-Zamora, ii.39. Macintyre sent me five from the Jatunyacu, 700 m., taken in March, 1937, and one male from Huagra-yacu, 900 m., Napo-Pastaza, 14.iv.41. A female from Hda. La Zatayacu, Rio Anzu, 600 m., Napo-Pastaza (*Macintyre*), stands as a full species in the collection of the A.N.S.P.

149c. **P. glaucolaus leucas** Rothschild & Jordan (p. 706). Macintyre has sent me two specimens he caught on the Jatunyacu, 700 m., in March, 1937, and one from Rio Jondachi, nr. Archidona, 800 m., xi.39, taken by the Olallas.

150a. **P. molops molops** Rothschild & Jordan (p. 710). Lad-

dey has sent me a specimen of this species from Palmar, 200 m., Manabi, 25.iv.41. It is much greener than *P. protesilaus archesilaus,* smaller and with much heavier marginal and submarginal bands on the forewing.

151e. **P. protesilaus archesilaus** Felder (p. 717). Macintyre and Schilling took a single male at Balzapamba, 630 m., Bolivar, 23.v.38.

156b. **P. telesilaus telesilaus** Felder (p. 725). Dr. Edw. Henderson gave me a specimen that he collected at Pacaiyacu on the Rio Bobonaza in September, 1938.

157b. **P. marchandi panamensis** Oberthür (p. 727). Laddey collected a single male at Santo Domingo de los Colorados, Pichincha, 500 m., 9.ii.41.

158a. **P. thyastes thyastinus** Oberthür (p. 728). Macintyre collected a single male at Puyo, 1000 m., Napo-Pastaza in May, 1937.

162. **P. leucaspis leucaspis** Godart (p. 733). We took 2 ♂♂ at Hda. San Francisco, 1300 m., 20, 22.ix.38, 1 ♂, Rio Margajitas, 1250 m., viii.38; 1 ♂, Rio Topo, 1226 m., 30.ix.38, and received from Macintyre 1 ♂, Hda. La Palmera, nr. Rio Topo, 1200 m., vii.38. All of these stations are within a few miles of each other on the Rio Pastaza. Coxey took single males at each of La Merced, Tungurahua and Hda. La Mascota, Napo-Pastaza. These are in the collection of the A.N.S.P.

163. **P. serville serville** Godart (p. 736). Macintyre has sent me a series of 6 ♂♂, 1 ♀ from the Jatunyacu, 700 m., taken in March, 1937. Coxey took 12 ♂♂ at Hda. La Mascota, Napo-Pastaza (*A.N.S.P.*).

A breakdown of the faunal affinities of the Papilios found on the two sides of the Andes in Ecuador is interesting and shows how strongly the fauna of the Pacific littoral and foothills is influenced by the Central American fauna. This western area is at present little known and I do not doubt but that further collecting will tend to strengthen rather than weaken this affinity.

Comparing the two faunæ we find that only 13 species are common to the two slopes, a matter of 22.8 per cent of the Papilios known to fly in Ecuador.

	Eastern Ecuador		Western Ecuador		All Eucador	
	No.	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*
Indigenous to Eucador	5	11.1	3	12.5	8	14.0
General neotropical species	14	31.1	9	37.5	15	26.3
C.A. race	(0)	(0)	(9)	(22)	......	....
S.A. race	(14)	(100)	(4)	(45)	......	....
Special race	(......)	(.........)	(3)	(33)	......	....
Andean	.....	....	1	4.2	1	1.7
North American species	1	2.2	1	4.2	1	1.7
South American species	21	46.6	2	8.3	21	36.8
Central American species	4	8.9	8	33.3	11	19.3
C.A. race	(0)	(0)	(2)	(25)	......	....
Special race	(4)	(100)	(6)	(75)	......	....
Total	45	99.9	24	100	57	99.8

RECORDS AND DESCRIPTIONS OF NEOTROPICAL CRANE-FLIES (TIPULIDÆ, DIPTERA), XIV

By CHARLES P. ALEXANDER
AMHERST, MASSACHUSETTS

The preceding part under this general title was published in December, 1941 (JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, 49: 345–356). The species discussed herewith are all from Ecuador and were collected in northwestern Ecuador (Manabi and Pichincha Provinces) by Mr. David B. Laddey and in Los Rios, Tungurahua and the Oriente by Mr. William Clark Macintyre and his co-workers. The types are preserved in my collection of these flies. I express my deepest thanks to Messrs. Laddey and Macintyre for their cooperation in making known the vast tipulid fauna of Ecuador.

Genus *Ozodicera* Westwood

Ozodicera (Ozodicera) multiermis new species.

General coloration brownish yellow, the praescutum with four ill-defined darker brown stripes that are very insensibly bordered by darker brown; wings yellowish brown, the prearcular and costal fields slightly more saturated; male hypopygium with the inner dististyle complex in structure, with three spinous arms.

MALE.—Length about 22 mm.; wing 19.5 mm.; antenna about 5.8 mm.

Frontal prolongation of head brownish yellow above, darker laterally; nasus distinct; palpi black. Antennæ with the basal nine segments obscure yellow, the terminal four simple segments black; flagellar branches slightly dusky. Head yellowish gray; eyes (male) large, the anterior vertex much reduced, about one-third the diameter of scape.

Pronotum brownish yellow. Mesonotal præscutum brownish yellow, with four ill-defined darker brown stripes that are very insensibly bordered by darker brown, especially the lateral stripes; remaining sclerites of notum chiefly yellow pollinose, the scutal lobes variegated by slightly darker brown. Pleura yellow pollinose, the ventral pleurotergite and sternopleurite more grayish pruinose. Halteres brown, the base of stem more yellowish, the knob darker brown. Legs with the coxæ yellowish gray pruinose; trochanters obscure yellow; femora yellow, the tips narrowly brownish black; tibiæ yellowish brown, the tips narrowly darkened; tarsi black. Wings yellowish brown, the prearcular and costal fields slightly more saturated; stigma long-oval, pale brown; veins brownish yellow. Venation: Cell M_1 broadly sessile.

Abdomen with basal tergite yellowish gray; succeeding tergites yellow, trivittate with brown, the latter becoming more extensive and restricting the ground color on the outer segments; sternites yellow; hypopygium yellow. Male hypopygium generally as in *trispinifer* but differing conspicuously in the structure of the ninth tergite and inner dististyle. Ninth tergite deeply notched medially, the lateral lobes thus formed slightly produced. Inner dististyle with three principal arms that are relatively slender, the outermost bearing a single lateral spine on margin. In *trispinifer* the tergite is very shallowly notched, the lateral lobes very low and obtuse; inner dististyle with the details of structure entirely different.

Habitat.—Ecuador (Oriente).

Holotype, ♂, Rio Jatun Yacu (Macintyre).

The nearest relative of the present fly is *Ozodicera* (*Ozodicera*) *trispinifer* Alexander, likewise from Amazonian Ecuador, which differs especially in the structure of the male hypopygium, as described above.

Genus *Tipula* Linnaeus

Tipula (Nephrotomodes) auricularis new species.

Mesonotum grayish brown, without evident stripes; antennæ (male) elongate, about two-thirds the length of wing; flagellum black, the segments long-cylindrical with poorly developed basal tubercles; wings with a weak brown tinge; stigma oval, dark brown; a restricted clouding along cord and outer end of cell *1st* M_2; vein R_{1+2} atrophied; male hypopygium with the outer dististyle large and conspicuous, shaped more or less like a dog's ear; inner dististyle appearing as a slender rod, expanded at apex into a triangular head; ninth sternite not or scarcely notched medially, the margin on either side of midline with a blackened bilobed structure that is densely covered with short erect setulæ.

MALE.—Length about 12 mm.; wing 11.5 mm.; antenna about 8 mm.

Frontal prolongation of head relatively short, obscure yellow above, dark brown beneath; nasus short and stout; palpi dark brown, the terminal segment somewhat paler. Antennæ (male) very long, approximately two-thirds the length of wing; scape, pedicel and basal half of first flagellar segment yellow, the remainder black; flagellar segments long-cylindrical, with poorly developed basal tubercles; verticils less than one-half the length of segments; terminal segment reduced. Head obscure yellow; vertical tubercle lacking; anterior vertex of moderate width, approximately twice the greatest diameter of scape.

Mesonotal præscutum and scutum grayish brown, without evident stripes, the scutellum and postnotum a very little paler; vestiture of præscutum very short and sparse. Pleura obscure yellow, the ventral sternopleurite and meron

restrictedly darker; dorsopleural membrane light yellow. Halteres with stem dusky, yellow at base, knob infuscated. Legs with coxæ obscure brownish yellow or grayish yellow; remainder of legs broken. Wings with a weak brownish tinge, the prearcular field and cells *C* and *Sc* slightly darker brown; stigma large, oval, dark brown; restricted dark seams on anterior cord and outer end of cell *1st* M_2; a more conspicuous dark seam on *m-cu;* more cream-colored areas before and beyond stigma; wing tip vaguely more darkened; veins brown. Venation: R_{1+2} more or less atrophied, in both wings of type preserved as a short weak detached element at costa, the remainder lacking; tip of vein M_3 atrophied; cell *2nd A* moderately wide.

Abdominal tergites and sternites yellow or brownish yellow, the caudal margins of the segments broadly brownish black, the basal portion of tergite two similarly darkened; segments seven and eight, with the caudal border of six more uniformly blackened; hypopygium yellow. Male hypopygium with the tergite separate from sternite; ninth sternite without a median incision, as usual in the genus, the caudal border truncate; on either side of the median line with a blackened bilobed structure, separated by a very deep and narrow U-shaped notch, the lobules unequal, each densely set with short erect setulæ. Ninth tergite with caudal margin gently and evenly emarginate; from beneath an elevated rim project two conspicuous lobes, these separated from one another by a U-shaped notch; lobes obliquely truncated, set with abundant short blackened pegs. Outer dististyle large and conspicuous, shaped more or less like a dog's ear, expanded on basal half, narrowed to the subacute tip; at base on mesal margin with a recurved glabrous flange; surface of mesal face with abundant long setæ. Inner dististyle of unusual shape, appearing as an elongate rod that is expanded at apex into a dusky triangular head, provided with several conspicuous setæ, the stem narrowest just before the expanded portions.

Habitat.—Ecuador (Manabi).

Holotype, ♂, Palmar, Playones, altitude 150 meters, May 15, 1941 (Laddey).

Tipula (*Nephrotomodes*) *auricularis* is entirely different from other regional species of the subgenus having a weak wing pattern, including *T.* (*N.*) *icasta* Alexander, *T.* (*N.*) *infida* Alexander, and *T.* (*N.*) *luctifica* Alexander, by the very distinctive male hypopygium. The subgenus *Nephrotomodes* Alexander (type, *smilodon* Alexander) was only recently proposed to include a host of species in Tropical America.

Tipula notoria new species.

Belongs to the *glaphyroptera* group; size small (wing, male, 13 mm. or less); general coloration gray, the præscutum with four entire dark brown stripes; antennæ (male) relatively long, virtually simple, flagellum beyond

the basal segment black; halteres elongate, yellow throughout; femora with a dark brown subterminal ring, the extreme tip yellow; wings handsomely patterned with creamy white, yellow, pale brown and dark brown, the yellow including a conspicuous area at arculus and the interspaces of cell *Sc; R_{1+2}* atrophied; abdomen brown, the more basal segments paler, the outer segments, including hypopygium, black; male hypopygium with the tergite produced caudad into conspicuous yellow sublateral ears; ventro-caudal lobe of basistyle very small, subglobular; eighth sternite unarmed.

MALE.—Length about 9–10 mm.; wing 12–13 mm.; antenna about 4–4.2 mm.

FEMALE.—Length about 13 mm.; wing 13.5 mm.

Frontal prolongation of head dark brown, nasus distinct; palpi black. Antennæ (male) relatively long, as shown by measurements; scape and pedicel yellow; first flagellar segment brownish yellow, remainder of flagellum black; flagellar segments cylindrical, the basal enlargements not or scarcely developed; verticils shorter than the segments, the longest series unilaterally arranged; terminal segment reduced to a tiny thimble. Head obscure yellow in front, passing into brownish gray behind; vertical tubercle very low and small.

Pronotum dark brown, variegated sublaterally with buffy. Mesonotal præscutum light gray, with four distinct dark brown stripes; posterior sclerites of notum dark brownish gray, the scutal lobes conspicuously variegated with dark brown. Pleura light gray, variegated with darker on ventral anepisternum, ventral sternopleurite and meron; dorsopleural membrane buffy. Halteres elongate, obscure yellow throughout. Legs with the coxæ gray pruinose; trochanters obscure yellow; femora pale brown with a dark brown subterminal ring, preceded and followed by clearer yellow, the apical area narrower; tibiæ yellowish brown, the tips weakly and narrowly darkened; tarsi dark brown. Wings creamy white and pale brown, the prearcular and costal portions variegated with darker brown and light yellow; cell *C* brown; cell *Sc* yellow, with four dark brown areas that are less extensive than the interspaces; post-stigmal brightening very variable in degree, in the male sex very restricted, in the female larger and more extensive; major white areas in cells *R*, R_1, *M*, *Cu* and *1st A;* a conspicuous yellow area at arculus, completely surrounded by brown markings; veins dark brown, excepting those in the yellow areas where they are of this color. Venation: R_{1+2} atrophied; cell *1st* M_2 relatively small, irregularly pentagonal; *m-cu* close to fork of M_{3+4} or beyond this point on M_4.

Abdomen brown, the more proximal segments slightly brightened sublaterally; basal sternites similarly pale; outer segments, including hypopygium, uniformly dark brown. Male hypopygium with the tergite produced caudad into conspicuous yellow sublateral ears, the caudal border between these lobes crenulate, glabrous. Ventro-caudal lobe of basistyle very small, subglobular, with about fifteen powerful setæ. Gonapophyses appearing as flattened, dark-colored blades, broadly dilated at base, before the small head constricted into a neck. Apex of ædeagus with two divergent acute spines, these taken

together forming a straight angle. Eighth sternite entirely unarmed, the margin simple.

Habitat.—Ecuador (Tungurahua).

Holotype, ♂, Pundoa, altitude 3,000 meters, July 12, 1939 (Macintyre). Allotopotype, ♀, pinned with type. Paratopotype, 1 ♂.

Tipula notoria is most similar to species such as *T. chicana* Alexander, *T. consonata* Alexander, *T. fraudulenta* Alexander, and *T. obirata* Alexander, differing from all in the pattern of the wings and in the structure of the male hypopygium.

Genus *Limonia* Meigen

Limonia (Limonia) lachesis new species.

General coloration of præscutum reddish yellow, patterned with dark brown, most evident as a broad, nearly lateral area; scutum, scutellum and postnotum uniformly blackened; pleura yellow, with a very broad and conspicuous longitudinal black stripe; knobs of halteres blackened; femora obscure yellow with a conspicuous, dark brown, subterminal ring; wings whitish, very heavily patterned with dark brown, the amount of dark color exceeding the ground areas, cell *M* almost entirely darkened; vein *Sc* short, Sc_1 ending a short distance beyond origin of *Rs*, Sc_2 exactly opposite this origin; *Rs* very strongly arcuated at origin; *m-cu* before fork of *M;* abdominal tergites black, sternites yellow, darkened laterally; cerci small and slender, upcurved.

FEMALE.—Length about 7 mm.; wing 7.8 mm.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval. Head gray; vertex reduced to a narrow strip that is about equal in width to one-half the diameter of scape.

Pronotum black. Mesonotal præscutum reddish yellow, patterned with dark brown, the discal areas reduced to a short and narrow median line on cephalic portion and the narrowly darkened interspaces, the broad, nearly lateral præscutal borders much wider and more conspicuous; scutum, scutellum and postnotum uniformly blackened. Pleura yellow with a very broad and conspicuous black longitudinal stripe extending from the cervical region to the postnotum; ventral sternopleurite narrowly and less heavily darkened; posterior dorsopleural region yellow. Halteres with stem yellow, knob blackened. Legs with coxæ and trochanters yellow; femora obscure yellow to brownish yellow, with a conspicuous, dark brown, subterminal ring, the apex abruptly yellow, a little less extensive than the darkened ring; tibiæ pale brown; tarsi broken. Wings with the ground color whitish, very heavily patterned with dark brown, the amount of dark color exceeding the pale ground in area; prearcular field yellowish; cells *C* and *Sc* pale yellow, becoming even paler outwardly; the dark areas include prearcular and postarcular markings; major areas at and beyond origin of *Rs;* stigma, cord, outer end of cell *1st* M_2

and outer radial field; a large area at one-third the length of cell *R;* all of cell *M* excepting outer end and a slight invasion near base; dark washes in cubital and anal cells; veins brown, brightened in the flavous areas. Venation: *Sc* short, Sc_1 ending only a short distance beyond origin of *Rs*, Sc_2 exactly opposite this origin; *Rs* strongly arcuated to almost square at origin; R_2 lying slightly distad of level of free tip of Sc_2; *m–cu* before fork of *M*.

Abdominal tergites black; sternites pale yellow, darkened laterally; valves of ovipositor reddish horn color, bases of hypovalvæ blackened. Ovipositor with cerci very small and slender, upcurved.

Habitat.—Ecuador (Tungurahua).

Holotype, ♀, Baños, altitude 2,000 meters, April 28, 1939 (Macintyre).

Limonia (*Limonia*) *lachesis* is entirely distinct from the species that superficially resemble it, as *L.* (*L.*) *indomita* Alexander and *L.* (*L.*) *macintyrei* Alexander. The nature of the wing pattern and venation, especially the relatively short *Sc*, readily distinguishes this fly from these generally similar species.

Genus *Orimarga* Osten Sacken

Orimarga (Diotrepha) syndactyla new species.

General coloration pale yellow, the pleura with a very narrow darkened longitudinal line; legs white, the tips of femora and tibiæ blackened; wings tinged with yellow, vaguely clouded with dusky along cord and at certain of the forks; abdomen yellow, the extreme caudal borders of the segments blackened; hypopygium dark; male hypopygium very large; dististyles completely fused for more than their basal two-thirds, the tips of both styles acute; inner dististyle with a linear row of conspicuous setæ along lower margin; phallosome very large and complex in structure.

MALE.—Length about 7 mm.; wing 4.5 mm.

Rostrum pale; palpi dark colored. Antennæ pale, of moderate length. Head discolored in the unique type.

Pronotum dark brown. Mesonotum uniformly pale yellow, the pleura similar, with a very narrow darkened longitudinal line extending from behind the fore coxæ across the dorsal sternopleurite, extending almost to root of halteres. Halteres yellow, the knob dark brown. Legs with the coxæ and trochanters yellow; femora white, the tips rather broadly and conspicuously black; tibiæ white, the tips narrowly and abruptly blackened, the amount about one-third as extensive as the femoral blackening; tibial bases not darkened; tarsi snowy white. Wings tinged with yellow, the prearcular and costal portions somewhat clearer yellow; small to scarcely evident dusky clouds at R_2, fork of *Rs* and along cord; veins yellow, a trifle darker in the clouded areas. Costal fringe relatively long and conspicuous. Venation: *Rs* long, strongly arcuated

at origin; Sc_1 ending about opposite four-fifths to five-sixths the length of *Rs*, Sc_2 at its extreme tip; free tip of Sc_2 faintly indicated, far before R_2, the distal section of R_1 alone being only a trifle less than R_{2+3}; R_{1+2} atrophied, its position barely indicated at point of union of R_1 and R_2; *m–cu* at near one-third the length of *M*; cell *2nd A* wide.

Abdomen elongate, yellow, the extreme caudal borders of the segments blackened to produce narrow rings; hypopygium yellowish brown to brown. Male hypopygium of unusual size, the styli especially long. Basistyle before apex on mesal face with two closely approximated powerful setæ, the other vestiture of style weak and scattered. Both dististyles entirely fused for more than their basal two-thirds, thence split into two parts, the outer style a long black spine, the inner style similarly produced at apex into a sharp point, the lower margin with a row of conspicuous setæ that become progressively longer toward outer end of row. Phallosome very large and complex in structure.

Habitat.—Ecuador (Pichincha).

Holotype, ♂, Santo Domingo de los Colorados, altitude 500 meters, September 12, 1940 (Laddey).

Orimarga (*Diotrepha*) *syndactyla* is entirely distinct from all other described members of the *mirabilis* group. The unusual size and structure of the male hypopygium readily separates the fly from the other species so far made known.

Genus *Hexatoma* Latreille

Hexatoma (Eriocera) manabiana new species.

Belongs to the "Penthoptera" group; thorax uniformly dark orange, the præscutum unpatterned; head dark gray; halteres elongate, black throughout; legs brownish black, the tarsi extensively white, the proximal ends of all basitarsi darkened; most extensive on fore pair; wings relatively broad, with an almost uniform yellow tinge, the tip undarkened; no stigmal area; *Rs* elongate, exceeding the total length of vein R_5; *m–cu* about one-half its length beyond the fork of *M*.

FEMALE.—Length about 10 mm.; wing 10 mm.

Rostrum and palpi black. Antennæ 7-segmented, relatively short, if bent backward ending shortly before the wing-root; scape and pedicel obscure brownish yellow, flagellum black. Head dark gray; anterior vertex of moderate width.

Prothorax and mesothorax almost uniform dark orange, the præscutum unpatterned; præscutal setæ very sparse; pleura and pleurontergite a trifle more yellow than the notum. Halteres elongate, black throughout. Legs with the coxæ orange-yellow; trochanters obscure yellow; femora and tibiæ brownish black; basitarsi brownish black on proximal portion on all legs, the tips whitened, least extensive on the fore legs where only the distal seventh or

eighth is included, widest on the posterior legs where at least the outer half is whitened; remaining tarsal segments white, the last segment weakly infuscated; posterior basitarsi much shorter than the fore pair. Wings relatively broad, with a strong and almost uniform yellowish tinge, the tip not darkened; stigma entirely lacking; veins brown. Abundant macrotrichia on all veins beyond cord. Venation: *Rs* elongate, exceeding the total length of vein R_5; R_{2+3+4} relatively short, a little exceeding R_{1+2}; R_{2+3} a trifle longer than R_2 alone; cell *1st* M_2 long-rectangular, a little shorter than vein M_{1+2} beyond it; *m–cu* about one-half its length beyond fork of *M*; cell *2nd A* relatively wide.

Abdominal tergites dark brown; sternites yellow; cerci darkened, the tips rather narrowly horn yellow.

Habitat.—Ecuador (Pichincha).

Holotype, ♀, Santo Domingo de los Colorados, altitude 500 meters, January 26, 1941 (Laddey).

The so-called "Penthoptera" or *chirothecata* group of the subgenus now includes several species in Tropical America, ranging as far to the south as southeastern Brazil. The present fly is closest to *Hexatoma* (*Eriocera*) *candidipes* Alexander and *H.* (*E.*) *intermedia* Alexander, differing from both in the coloration of the legs and wings. The various Neotropical species of the group are best separated by the nature of the præscutal pattern, when present; the degree of white color on the basitarsi; the wing pattern, and the details of venation.

Hexatoma (Eriocera) laddeyi new species.

Thorax almost uniformly orange, scarcely patterned; head dull black; legs and halteres black; wings brownish yellow, sparsely patterned with darker brown, including cell *Sc*, stigma, wing tip, and seams along veins beyond the cord; abundant macrotrichia on veins beyond cord; R_{1+2} about two-fifths the length of the long, gently arcuated R_{2+3+4}; *m–cu* more than one-half its length beyond fork of *M*; abdomen dark brown, the tergites more reddish laterally; cerci long and slender, blackened basally.

FEMALE.—Length about 12 mm.; wing 11.5 mm.; antenna about 2 mm.

Rostrum and palpi brownish black. Antennæ 8-segmented; scape and pedicel dark brown, deeper in color above; flagellum black; flagellar segments gradually decreasing in length and diameter outwardly. Head dull black, the surface very sparsely pruinose; anterior vertex broad; vertical tubercle low.

Pronotum brown. Mesothorax almost uniform deep orange, the notum with a darkened V-shaped mark at the center of the suture; præscutal stripes not or scarcely differentiated; pleura somewhat more yellowish; vestiture of præscutal interspaces very short and sparse. Halteres black. Legs with the coxæ and trochanters obscure yellow; femora black, the bases very narrowly

and insensibly brightened; tibiæ and tarsi black. Wings with a brownish yellow tinge, sparsely patterned with darker; cell *Sc* uniformly darker brown; stigmal area dark but very restricted and confluent with the subcostal infuscation; cord and the veins beyond it slightly seamed with brown; wing-tip weakly darkened; veins dark brown. Abundant macrotrichia on all veins beyond cord. Venation: Sc_1 ending shortly beyond fork of *Rs*, Sc_2 just before this fork; R_2 oblique subequal to R_{2+3}; R_{1+2} about two-fifths the length of the long, gently arcuated R_{2+3+4}; cell *1st* M_2 rectangular, a little shorter than vein C_{1+2} beyond it; *m–cu* about two-thirds to three-fourths its own length beyond fork of *M*, longer than distal section of Cu_1; cell *2nd A* relatively wide.

Abdominal tergites dark brown, more reddened laterally; sternites obscure yellow, the posterior borders narrowly darkened; genital shield dark chestnut brown; cerci long and slender, blackened on basal half, the gently upcurved tips pale horn yellow.

Habitat.—Ecuador (Pichincha).

Holotype, ♀, Santo Domingo de los Colorados, altitude 500 meters, February 7, 1941 (Laddey).

I am very pleased to name this distinct fly in honor of the collector, Mr. David B. Laddey, who has added materially to our knowledge of the Tipulidæ of Ecuador. The nearest relative is *Hexatoma* (*Eriocera*) *semirufa* Alexander, of Venezuela (*dimidiata* Alexander, 1923, nec *dimidiata* Henriksen, 1922) which differs conspicuously in the coloration of the body and wings and in the details of venation.

Hexatoma (Eriocera) piatrix new species.

General coloration of thorax black, with strong bluish and purplish reflexions; head intense black; halteres and legs black; wings relatively broad, with a strong blackish tinge, the centers of many of the cells paler; relatively sparse macrotrichia on veins R_4 and distal section of R_5; abdomen, including hypopygium, black.

MALE.—Length about 11.5 mm.; wing 10.5 mm.

Rostrum and palpi black. Antennæ short, 6-segmented; scape and pedicel dark brown, the flagellum a trifle paler brown; flagellar segments one to three gradually decreasing in length, the terminal segment more elongate, about one-fourth longer than the penultimate; basal two flagellar segments stouter, terminal two with more abundant and conspicuous setæ. Head intense black; vertical tubercle nearly entire.

Thorax black, with strong bluish and purplish reflexions; præscutum without pattern; setæ of interspaces short and relatively sparse. Halteres short, black throughout. Legs black. Wings relatively broad, with a strong blackish tinge, the costal border a trifle more strongly darkened; centers of many

of the cells, especially R_1, M_1, M_4, *1st A* and *2nd A* with markedly paler areas; stigma lacking; veins pale brown, inconspicuous against the ground. Relatively sparse trichia on veins R_4 and distal section of R_5, entirely lacking on other veins beyond cord, including R_2 and R_{1+2}; costal trichia before *h* more erect and conspicuous than those beyond. Venation: Sc_2 close to tip of Sc_1, both beyond level of fork of *Rs*; R_{1+2} longer than R_{2+3} but only a little more than one-half R_{2+3+4}; basal section of R_5 a little more than one-half R_{2+3+4}; *m–cu* shortly beyond fork of *M*; distal section of Cu_1 shorter than *m–cu*; prearcular field short.

Abdomen, including hypopygium, black, the caudal borders of the segments narrowly more glabrous but not different in color.

Habitat.—Ecuador (Pichincha).

Holotype, ♂, Santo Domingo de los Colorados, altitude 500 meters, February 22, 1941 (Laddey).

Hexatoma (*Eriocera*) *piatrix* is most similar to *H.* (*E.*) *lessepsi* (Osten Sacken) which differs in the details of venation and in the coloration of the body, especially the orange-red head.

Hexatoma (Eriocera) magistra new species.

Mesonotal præscutum dark brown, the four stripes yellow pollinose; head fiery orange; antennæ with scape and pedicel light yellow, flagellum black; halteres short; stem yellow, knob brown; femora yellow, the tips narrowly but conspicuously black, the amount subequal on all legs; tarsi black; wings brown, crossbanded with yellow, the broad apex brown; veins beyond cord, with the exception of R_5, without trichia; abdominal tergites orange, segments six and seven broadly darkened but with the lateral borders pale.

FEMALE.—Length about 13.5 mm.; wing 12 mm.; antenna about 3.2 mm.

Rostrum yellow; palpi with first and last segments yellow, the intermediate segments brown. Antennæ 8-segmented; scape and pedicel light yellow, flagellum black; flagellar segments one to three gradually decreasing in length, four and five subequal, terminal segment a trifle shorter. Head fiery orange; anterior vertex low; vertical tubercle relatively inconspicuous, feebly notched at summit.

Pronotum brown, more yellowish pollinose on sides. Mesonotal præscutum with the ground color dark brown, the four præscutal stripes yellow pollinose, somewhat more obscured near the suture; posterior sclerites of notum light chestnut yellow to pale brown. Pleura obscure yellow, sparsely variegated with brown on ventral anepisternum and ventral sternopleurite. Halteres relatively short, stem yellow, knob brown. Legs with the coxæ and trochanters yellow; femora yellow, the tips narrowly but conspicuously black, the amount subequal on all legs; tibiæ obscure yellow basally, passing into black at tips; tarsi black. Wings with the ground color brown, crossbanded with yellow; the brown color includes the broad entire wing-tip, its inner level

extending about to the cord; inner dark band at level of origin of *Rs*, paler brown; cell *2nd A* similarly pale brown; the yellow color includes cells *C* and *Sc*, a broad band chiefly before cord, and the extreme bases of cells *Cu* and *1st A*; proximal portions of cells *R* and *M* still more weakly darkened; veins pale brown in the patterned areas, yellow in the brightened portions. Veins beyond cord, with the exception of R_5, without trichia. Venation: *Rs* very long, exceeding the total length of vein R_5; R_{2+3+4} short, a little exceeding R_{1+2}; cell *1st* M_2 short, less than any of the veins beyond it; *m–cu* a short distance beyond the fork of *M*.

Abdominal tergites orange; central portions of tergites six and seven more darkened to form an incomplete ring, the lateral portions remaining yellow; sternites yellow, more or less discolored, the posterior borders pale; genital segment and ovipositor orange; cerci long and slender.

Habitat.—Ecuador (Oriente).

Holotype, ♀, Rio Huagra Yacu, altitude 900 meters, April 5, 1941 (Macintyre).

The most similar species are *Hexatoma* (*Eriocera*) *ferax* Alexander and *H.* (*E.*) *jurata* Alexander which have the wing pattern generally similar but differ in all details of body, leg and wing coloration, and in the venation.

Hexatoma (Eriocera) plumbeicolor new species.

General coloration black, the head and thorax sparsely pruinose to produce a leaden appearance; abdomen uniformly black; antennæ (male) 7-segmented, black throughout; halteres weakly darkened; legs black, the tibial bases a little paler; wings with a brown suffusion, costal and stigmal regions a trifle darker; veins beyond cord, with exception of R_5, without trichia; R_{2+3+4} relatively long, about three times the basal section of R_5; *m–cu* beyond fork of *M*.

MALE.—Length about 12–13 mm.; wing 10–11 mm.; antenna about 2.5 mm.

Rostrum and palpi dark brown. Antennæ (male) 7-segmented, black throughout; flagellar segments decreasing in length outwardly, the penultimate a little exceeding the preceding segment; terminal segment a little less than one-fourth the length of the penultimate segment. Head black, sparsely pruinose.

Pronotum black, sparsely pruinose. Mesonotum dull black, without markings, the surface very sparsely pruinose. Pleura black, very sparsely pruinose; dorsopleural membrane dark. Halteres very weakly darkened throughout. Legs with the coxæ black, very sparsely pruinose; remainder of legs black, the bases of tibiæ a trifle paler; claws (male) with conspicuous basal spine. Wings with a brown suffusion, the cephalic portion of prearcular field pale yellow; costal and stigmal regions a trifle darker than remainder of ground; basal cells with pale linear streaks; veins pale brown. Outer veins without trichia excepting an almost complete series on R_5. Venation: R_{2+3+4}

relatively long, about three times the basal section of R_5; veins R_3 and R_4 becoming paler and weaker toward wing margin; cell *1st* M_2 shorter than vein M_4 beyond it; *m–cu* from one-third to one-fourth its length beyond the fork of M.

Abdomen black throughout, without pruinosity; hypopygium with basistyle more reddish brown.

Habitat.—Ecuador (Los Rios).

Holotype, ♂, Playas de Montalvo, altitude 15 meters, March 17, 1938 (Macintyre). Paratopotype, ♂.

Hexatoma (Eriocera) plumbeicolor is quite distinct from somewhat similar uniformly darkened species of the subgenus. Among such forms it is most similar to *H. (E.) cornigera* (Alexander) and *H. (E.) pallidipes* (Alexander), yet quite distinct.

ELECTRON MICROGRAPHS OF INSECT TRACHEÆ[1]

By A. Glenn Richards, Jr.[2] and Thomas F. Anderson[3]

This paper presents electron micrographs of the tracheæ of mosquito larvæ, pupæ and adults (*Culex pipiens* L.) tracheæ, air-sacs and tracheoles of the adult worker honey bee (*Apis mellifica* L.) and tracheæ of the adult American cockroach (*Periplaneta americana*). Many of the minute details are considerably beyond the resolving powers of the light microscope and so are shown for the first time.

A discussion of the application of electron optics to insect cuticle studies is given in another paper (Richards & Anderson, 1942.) Descriptions and discussions of electron microscopes are given by Zworykin (1941); Zworykin, Hillier & Vance (1941); Hillier & Vance (1941); Smith (1941); Burton & Kohl (1942); Anderson (1942), etc.

TECHNIQUE

The technique is relatively simple. Tracheæ and air-sacs were dissected out and passed through several changes of distilled water for 1–24 hours to remove all the surrounding cells. The remaining clean intima is placed on thin collodion membranes across a fine-mesh wire screen (Richards & Anderson, 1942). Since best resolution is obtained from single layers, most of the tracheæ were deliberately torn open.

Very small tracheæ and tracheoles cannot be readily handled as such. Whole organs (nerve cord, portions of alimentary tract, etc.) were removed, the cells dissolved away by immersion in several changes of distilled water ($5\frac{1}{2}$ to 24 hours), and the re-

1 Thanks are due to the Radio Corporation of America and to Dr. V. K. Zworykin for use of the electron microscopes in the RCA Research Laboratories, and to the National Research Council's Committee on Biological Applications of the Electron Microscope, through which arrangements for this work were made.

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maining tissue teased apart and mounted on a collodion film across a wire screen.

Numerous specimens were also mounted in Apathy's gum syrup[4] for check study with the light microscope. Similar permanent mounts were eventually made of specimens studied in the electron microscope. Serial sections were also used in these comparative studies.

LITERATURE ON TRACHEAL STRUCTURE

Most of the papers on insect tracheæ deal either with their distribution or functioning; literature on tracheal structure is not extensive. It is generally stated that there are tracheæ, tracheoles and air-sacs. The tracheæ are cylinders (sometimes collapsible) supported by many helical thickenings called tænidia; the tracheoles are minute (less than 1 μ diameter) terminal branches of the tracheæ usually distinguished by the reported absence of tænidia; the air-sacs are distensible sacs, without tænidia, on the tracheæ of some insects. In the large tracheæ of some species of insects the walls are thick, and staining reactions show they possess the same layers as the cuticle of the exoskeleton (Weber, 1933); in other species the tracheal walls are extremely thin and no such differentiation is demonstrable.

Variations have been studied principally by Marcu (1929–1931) who found large spines on the tænidia of certain beetle tracheæ, linear thickenings in the tracheæ of other beetles and an irregular meshwork in the membrane between tænidia of various bees and wasps. See also Dujardin (1849), Stokes (1893), Packard (1898), Weber (1933) and Wigglesworth (1939).

TRACHEÆ OF THE MOSQUITO (CULEX PIPIENS)

LARVA: The intima of the two main longitudinal tracheal trunks is a thin, brown membrane with typical helical thickenings (tænidia). The thickness of the membrane was not determined accurately but cannot be more than 0.02 μ in dried tracheæ. The tænidia are readily visible with the light microscope since they are 0.3 to 0.7 μ wide (in areas shown in the micrographs the range

[4] 50 grams gum arabic, 50 grams sucrose, 50 cc. distilled water and 1 cc. formol. Dissolve the gum arabic in warm water, add sucrose and dissolve, cool, filter and add formol.

is 0.3–0.6 μ); they are opaque to 50 kV and 100 kV electrons (Fig. 3) but are readily penetrated by 200 kV electrons (Fig. 1); obviously a single tænidium may end either by anastamosis with another (Fig. 1) or tapering off into the membrane (Fig. 4). The tænidia and in some regions the membrane also bear minute spines (microtrichiæ) which are not limited to the region adjacent to the spiracles but occur throughout the length of the longitudinal trunks (not on the lateral branches, Figs. 1, 3, 4). These spines are of quite diverse sizes and shapes (Fig. 3); the average length is about 0.1 μ with a normal range of 0.08–0.15 μ, but much smaller ones also occur with the extremes being mere lumps not over 0.02 μ.[5] Most of the spines do not project into the lumen of the trachea but arise from the sides of the tænidia and project parallel to the membrane; about 25 per cent of them project more or less into the lumen but very few (less than 10 per cent) project directly into the lumen (Fig. 1).

Figure 3 has resolution of points to 0.004 μ or slightly smaller. The membrane is uniform. Accordingly this membrane in the dried state cannot have any pores larger than 0.004 μ diameter.

The large lateral tracheæ arising from the main trunk have a similar appearance under the light microscope but electron micrographs show that they lack the minute spines on the tænidia and membrane (Figs. 5–7). The thickness of the membrane as determined by the thickness of the dark rim along tracheæ that have not collapsed is 0.01 μ to less than 0.02 μ (Fig. 5 is especially favorable for this measurement because it is taken at a higher voltage than the other similar figures). Similar but less accurate figures may be obtained by comparing the density of the tracheal membrane with that of the collodion membrane; this is readily done at points where the tracheal membrane overlies a hole in the collodion film (arrow in Fig. 7).[6] How much shrinkage is involved in drying is not known. The tænidia shrink less than 25 per cent (likely much less); even if we allowed such a high value

[5] These clearly not due to foreshortening as can be shown by comparison with figure 1.

[6] Allowance should be made for differences in density. The specific gravity of the tracheal intima is not known but the specific gravity of pure chitin is 1.40 (Sollas, 1907) whereas the specific gravity of collodion (nitrocellulose) is approximately 1.66 (Hodgman, 1935).

for shrinkage of the intertænidial membrane on drying this membrane would still average less than 0.02 μ thick.

In most of the electron micrographs the tænidia appear as though outside the intervening membrane (Fig. 5). This must be due to irregular shrinkage since some of the micrographs show the tænidia in their normal position on the lumen side of the trachea (Fig. 6).

Most striking in appearance are the bands of large spines that encircle the main tracheal trunk and interrupt the tænidia (Fig. 4). These seem not to have been reported heretofore although they are readily visible with the light microscope. They occur as bilaterally symmetrical segmental bands immediately posterior (4–15 tænidia) to the origin of the main lateral segmental tracheæ. There are therefore eight pairs of these in the abdomen, all far removed both from the larval spiracles and from the sites of the future adult spiracles. These bands consist of spines which project directly into the lumen of the trachea. In the electron micrograph the spines appear shorter than they actually are (due to foreshortening); measurements in sections using the light microscope show these spines are 2–3 μ, mostly around 3 μ long. Between the spines is a meshwork of thickenings of the intima. This meshwork connects with the adjacent tænidia and runs into the spines in such manner that it seems the spines are formed from the outward projection of a focal cone of the meshwork.

Study of serial sections with the light microscope shows no obvious anatomical association of these spinose bands except with the trachea itself; also no differences between the cells which underlie this and other parts of the trachea. Examination of shed skins shows that in part at least these bands serve as fracture points for the main tracheal trunks during moulting,[7] but the tracheal trunks may also break at other points. Their elaborate structure suggests that they might also serve some other purpose. These tracheal trunks pulsate rhythmically (Babak, 1912). When the pulsating trachea is almost completely collapsed in the regions of these bands, the spines interlock and partially occlude the trachea. Conceivably these intermeshed spines could serve as a sieve to strain dust particles from the air but this would not

[7] Suggested by Dr. John B. Schmitt.

seem of great importance since they are far removed from the spiracles and since in the many specimens examined no accumulation of debris was ever seen in the trachea. Another suggestion is that these bands when interlocked serve as check valves to assist in the movement of air along the pulsating trachea.

Shed skins of mosquito larvæ gave similar micrographs but also revealed one additional point. In general, the tracheal intima is shed and pulled out during each moult but it would seem that this does not always occur. Figures 16–17 are stereoptic pictures of large lateral tracheal branches from the shed skin of a third instar larva. Examination of these pictures in a stereoscope shows that the smaller helix is within the larger helix. Obviously, then, these are double tubes (such double tubes were observed commonly on the fluorescent screen). Conceivably the tracheal intima might split but the inner tube is definitely smaller; it seems more likely that the inner tube represents the tracheal intima of the second instar larva, that this intima was not pulled out at the second moult, that the third instar larva had a double intima, and that both of these were withdrawn together at the third moult. If this interpretation is correct, it is interesting to note the close agreement of the tænidia in successive instars.

PUPA: The main longitudinal tracheal trunks of the abdomen lack the dark pigment that is present in larval tracheæ. They show spinose bands and minute spines on the tænidia similar to those of the larvæ. Some of the tracheæ are indistinguishable from larval tracheæ, but some of them are strikingly different in that the intertænidial membrane instead of being uniform has a definite reticulation of thickenings (Fig. 8).

ADULT: Only a few tracheæ from near the sixth abdominal spiracle were examined. The intertænidial membrane is not perfectly uniform, and the tænidia, instead of always being helices are some helices, some rings (Fig. 9).[8]

TRACHEÆ, AIR-SACS AND TRACHEOLES OF THE HONEY BEE (APIS MELLIFICA)

In the tracheæ of adult worker honey bees Marcu (1930) has already described and figured (photomicrographs) what he con-

[8] That the tænidia may sometimes be rings rather than helices is already known. See Snodgrass 1935, p. 448.

sidered braces extending from the tænidia onto the intertænidial membrane. Electron micrographs show the details are much finer than this. The tænidia have wavy edges, and an irregular meshwork of thickenings is present in the intertænidial membrane. The pattern is not constant but two principal types were observed: one in which the thickenings are more or less bead-like or knobbed (Fig. 10) and one in which there are few beads or knobs (Fig. 11). The larger of these thickenings approach the size of the tænidia; the smallest of the clearly resolved thickenings approximate 0.015 μ broad. Tracheoles did not possess such thickenings but we did not check a full graded series to determine at what size tube they disappear.

The thickness of the tracheal membrane cannot be determined accurately from the thickness of the edge of the tube because of interference by the thickenings. It seems to be of the general order of 0.01 μ in dry tracheæ.

The air-sacs have a very irregular meshwork of thickenings of various sizes (Fig. 12).

Considerable time was spent searching for tracheoles. Many were seen on the fluorescent screen of the microscope but only three less than 0.5 μ in diameter were sufficiently free of debris for micrographing. All sizes of tracheæ from the large main tracheæ to small tracheæ less than 0.2 μ in diameter after drying[9] were examined. All of these possessed tænidia (Fig. 15). Accordingly the main morphological characteristic for differentiation between tracheæ and tracheoles is invalidated. The tænidium (about 0.025 μ wide[10]) in these tracheoles, like that in large tracheæ, is not a continuous helix but it differs from the tænidia of large tracheæ in that one thread makes 6–8 turns around the tube and then ends, overlapping only slightly or not at all with the next helix. Other micrographs not being published show a

[9] The two smallest seen clearly were each collapsed as shown by the shape of the helical thickening. They each had a calculated diameter of 0.175 μ. Allowing for 10 per cent shrinkage (Richards & Anderson, 1942) and the probable error in calibration and measurement, these two are still less than 0.20 μ in diameter after drying.

[10] Equally small and even smaller anatomical details are found in the brilliant iridescent wing-scales of the butterfly *Morpho cypris* (Anderson & Richards, 1942).

tracheole of approximately 0.2 μ diameter ending blindly with the tænidium extending all the way to the closed end. Another micrograph of a tracheole about 0.35 μ in diameter shows several denser regions where the tænidia are more tightly coiled.

The intertænidial membrane of tracheoles is very thin. The specimen shown in figure 15 obviously moved during micrographing. This is shown by the double silhouette line indicated by the arrow. Using the clearer outer line for measurement, this membrane would be only 0.005 μ thick in dry state. The probable error here is high because such a magnitude is near the limit of resolution, but certainly this membrane must be considerably less than 0.01 μ thick.

TRACHEÆ OF THE COCKROACH (PERIPLANETA AMERICANA)

Tracheæ were taken from branches around the gut. The larger tracheæ differ from both of the preceding species in having circular or oval thickenings in the intertænidial membrane (Fig. 13). These are 0.15–0.25 μ broad and of approximately the same thickness (shown by one micrograph in which the membrane is torn and curled over, showing the thickenings as lumps along the edge). Small tracheæ (1–2 μ diameter) have only few or none of these thickenings.

The thickness of the intertænidial membrane was not determined accurately. It seems to be slightly thicker than in the preceding two species but is not over 0.05 μ thick.

One small trachea about 1.5 μ in diameter showed the tænidia as short helices, incomplete rings and complete rings (Fig. 14).

DISCUSSION

Aside from the unsuspected minuteness of details shown by these micrographs of tracheæ, four points warrant brief discussion. These are: (1) what is a tracheole? (2) what is the origin and development of tænidia and other thickenings? (3) what is the reason for the uniformity of the very thin membranes? and (4) what are the smallest sizes of cuticular structures that can be seen with the light microscope?

(1) The common definition of a tracheole is a small tube (less than 1 μ) lacking a tænidium. This is obviously invalidated by

the present work. Other characteristics that have been given are that they arise intracellularly (Tiegs, 1922; Wigglesworth, 1939), that they anastamose or end blindly (Wigglesworth, 1939), that they are freely permeable (Wigglesworth, 1938; Bult, 1939), that they are completely dissolved at the time of moulting whereas the tracheal intima is shed (Tiegs, 1922), and that they are not chitinous (Campbell, 1929). While the above may be perfectly good differences they are not always useful in differentiating between tracheæ and tracheoles. Probably the best characteristic left is the intracellular origin of tracheoles versus the origin of tracheæ from a tube of cells. But it is not certain that this criterion is always valid though it would seem necessary for tubes less than 1 μ in diameter to develop in this manner, and it is not possible to apply this differential characteristic in those cases where the tracheole passes gradually into the trachea (*i.e.*, no tracheal end cell present).

(2) The tænidia have been said to originate as folds in the tracheal intima. This view was put forward by Macloskie (1884) who considered the tænidia as hollow tubules. Obviously the tænidia are solid structures in the two species treated in this paper, and they are generally treated as solid in current textbooks although some recent authors refer to them as originating from folds (Wigglesworth, 1939). One can imagine the larger elements of the thickenings in the bee air-sac (Fig. 12) arising in this manner. It is conceivable that the tænidia might originate as folds but their density shows that they are not tubes and that the folds would have to act as regions for the accumulation of further secreted material. An alternative view holds that the tænidia represent a discontinuous exocuticula (Weber, 1933). The similarity in appearance of tænidia from various sources suggests a common explanation. A helical thickening only 0.025 μ broad suggests that large-scale polymer phenomena may be involved as at least the basic mechanism in tænidial development. This polymerization might well have similarities to the polymerization involved in the differentiation of the exocuticle of the exoskeleton.

Diversity of pattern of the membrane thickenings and smooth membrane in mosquito larvæ complicate interpretation both of

these thickenings and of tænidia. The smaller meshwork of the tracheæ of bees and mosquito pupæ (Figs. 8, 10, 11) certainly does not look like a pattern of folds, and the lumps in cockroach tracheæ seem even less like folds (Fig. 13), but these might represent polymerization patterns with differences between various tracheæ correlated with differences in chemical structure (Campbell, 1929; Wigglesworth, 1939). Certainly the magnitudes are such as to suggest a chemical rather than a morphological explanation.

(3) There is general agreement that the larger tracheæ contain chitin (Koch, 1932; Wigglesworth, 1939). In some cases (*e.g.*, mosquito larvæ) they certainly contain pigment. Probably like the cuticle of the exoskeleton they also contain protein. The intima of large tracheæ seems to be composed of two layers as is the general exoskeleton: a hydrophobic epicuticle and an underlying chitinous endocuticle (or equivalents). In view of the uncertainty concerning the chemical constitution of tracheæ it is not possible to interpret the fact that tracheæ show uniform membranes which when dry are only 0.01–0.02 μ thick.

The membranes of tracheoles are thinner than those of tracheæ. This might be due to the probable absence of a hydrophobic lining or to a different chemical constitution (no one has been able to demonstrate the presence of chitin in the walls of these minute tubules. See Wigglesworth, 1939).

Yet these membranes are so perfectly uniform both over considerable areas in one trachea and from one trachea to another that their origin could be most readily visualized as a mono-layer. But apparently they cannot represent a mono-layer of chitin crystallites.[11] It remains to be seen whether a polymer or lattice unit will be found of sufficient size to account for the thickness of these thin membranes.[12] Obviously these remarks do not pertain to thick-walled tracheæ such as figured by Weber (1933, Fig. 393).

(4) Using the light microscope there is no difficulty in discerning the tracheal membranes in cross sections of tracheæ despite

[11] For size of chitin micellæ see Clark & Smith (1936).

[12] The fact that the smaller thickenings in the honey bee tracheæ are approximately twice the thickness of the membrane may be of some significance.

these membranes being only 0.01–0.02 μ thick. Usually the membrane is accentuated by the surrounding cells but it may be seen even when alone. The much larger thickenings in this membrane and the barbs on the tænidia of mosquito larvæ are scarcely discernible though by careful focusing slight irregularities can be detected (Fig. 2). Increased distinctness can be obtained by mounting air-filled tracheæ in Apathy's gum syrup and selecting points where the air-bubbles accentuate the contrast. In a few such mounts of mosquito tracheæ the barbs (0.1 μ) on the tænidia are fairly clear though they all look alike, and the meshwork (about 0.15 μ) between spines of the spinose band is detectable though not clear—the difference in resolution here being due to differences in degree of contrast. This is merely a graphic demonstration of the well-known fact that the ability to see objects depends not only on the optical system used but also on the question of what one is trying to see. Separation of two closely spaced spots is more difficult than recognition of a single structure of the same dimensions. The visible-light microscope has a limit of resolution of 0.2 μ but single structures much smaller than this can be seen especially if one of the two dimensions is large and the contrast is high. With the electron microscope such minute structures can be seen clearly and measured accurately.

SUMMARY

1. Electron micrographs of the intima (cuticular lining) of tracheæ of the house mosquito, the honey bee and the American cockroach show structural details extending approximately to 0.015 μ.

2. The thickness of the intertænidial membrane of larger tracheæ of these species is 0.01–0.02 μ after drying; it seems probable that it averages less than 0.02 μ in life. The thickness of the intertænidial membrane of tracheoles after drying seems to be considerably less than 0.01 μ and may be only 0.005 μ.

3. Electron micrographs of tracheæ show no pores in the thin membrane. Since resolution in the best micrographs is at least to 0.004 μ, it is probable that the dry tracheal intima has no pores of this magnitude.

4. Tracheoles (honey bee) less than 0.2 μ in diameter have a helical tænidium 0.02–0.03 μ wide. Thus tracheoles, as well as tracheæ, are shown to possess supporting tænidia. This point can no longer be used to differentiate between tracheæ and tracheoles.

5. Some tracheæ of both adult mosquitoes and cockroaches show tænidia as helices, incomplete rings and complete rings.

6. Some stereoscopic micrographs of tracheæ from shed skins of mosquito larvæ show one spiral inside another. This indicates that the tracheal intima is not necessarily all withdrawn at each moult.

7. Tracheæ of mosquito larvæ have minute spines averaging 0.10 μ in length on the tænidia of the main longitudinal tracheæ. Segmentally arranged, bilaterally symmetrical spinose bands interrupt the tænidia of these main longitudinal trunks just posterior to the origin of the lateral tracheæ.

8. Tracheæ of mosquito larvæ and pupæ differ in that all larval tracheæ observed have uniform intertænidial membranes whereas some pupal tracheæ show reticulate thickenings. Accordingly the tracheal pattern is not necessarily constant throughout the life cycle of the species.

9. The tracheal intima of the honey bee shows complicated thickenings of several types.

10. The tracheal intima of the cockroach shows small swollen knobs.

11. It does not seem likely that these patterns could all originate from foldings of the intima; it is suggested that polymer phenomena may be involved in the development of these thickenings, in the development of tænidia, and in the development of uniform thin membranes.

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PLATE VIII

Figure 1. Electron micrograph of portion of longitudinal tracheal trunk of mosquito larva. 200 kV electrons. Magnification 6,550 ×.

Figure 2. Photomicrograph of same. Magnification 1,450 ×.

Figure 3. Electron micrograph of portion of same. 100 kV electrons. Magnification 14,550 ×.

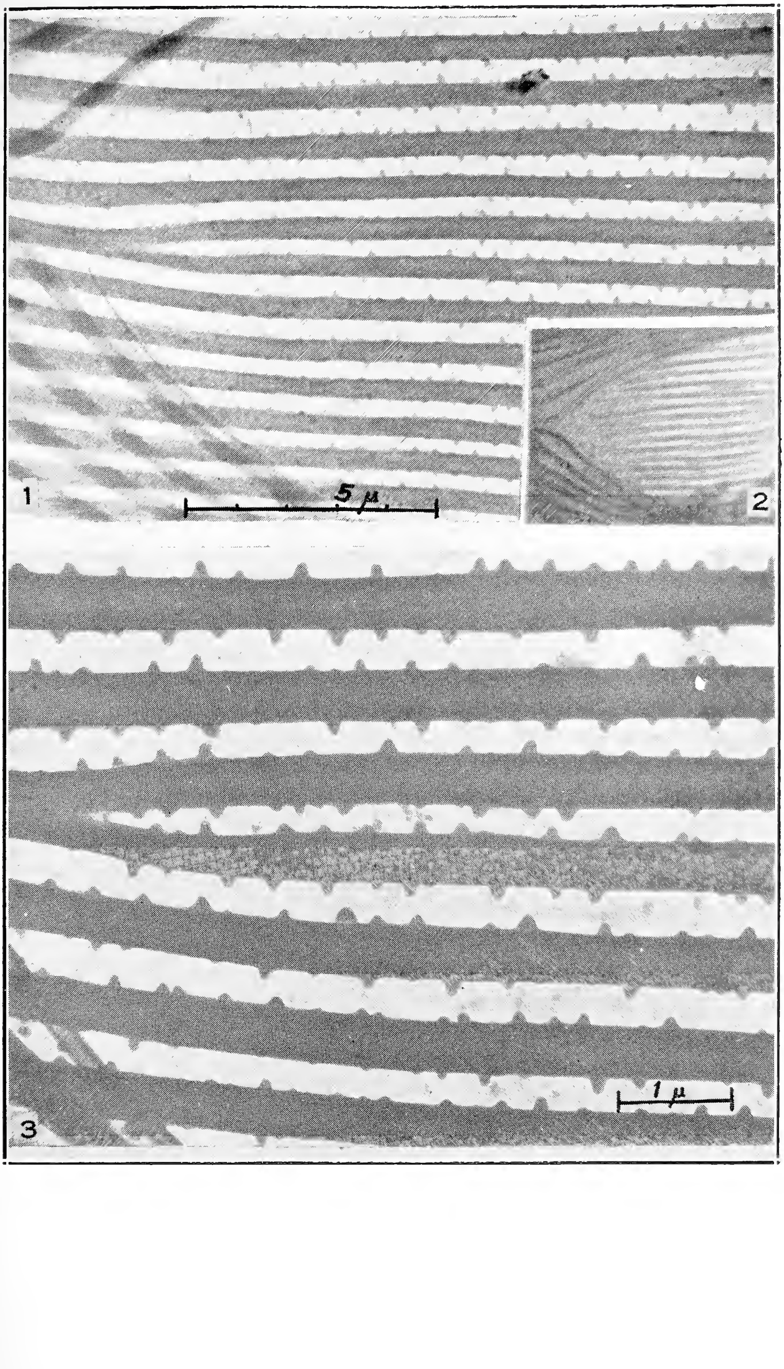

1
5 μ
2
3
1 μ

PLATE IX

Figure 4. Electron micrograph of portion of spinose band from longitudinal tracheal trunk of mosquito larva. 200 kV electrons. Magnification 7,500 ×.

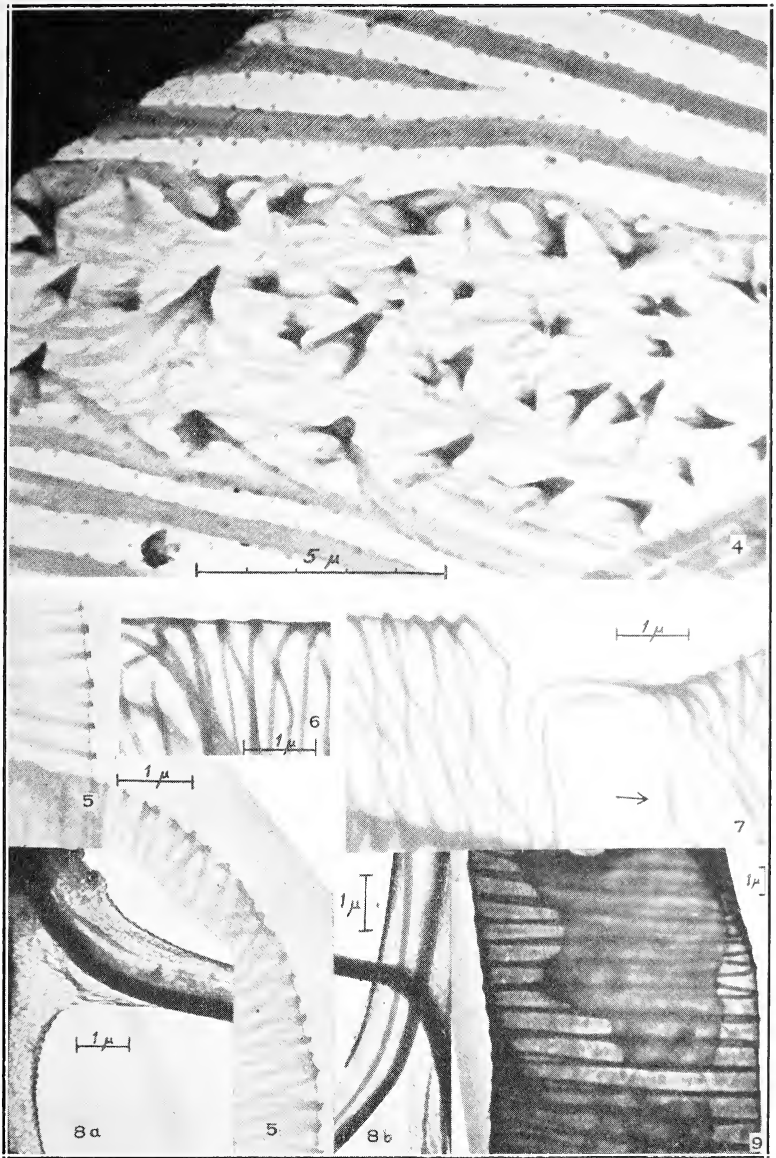
Figure 5. Micrograph of parts of two of the lateral tracheæ that arise from the longitudinal tracheal trunk of mosquito larva. 100 kV electrons. Magnification 9,500 ×.

Figure 6. Micrograph of another specimen of same. 60 kV electrons. Magnification 9,250 ×.

Figure 7. Micrograph of another specimen of same. This is one of a pair of stereoptic pictures; examination with a stereopticon shows clearly that these have not collapsed. The arrow points to a hole in the collodion membrane where the density of the tracheal membrane can be readily compared with that of the collodion membrane. 60 kV electrons. Magnification 9,250 ×.

Figure 8. Micrograph of portion of trachea from mosquito pupa. (a) and (b) different parts of same micrograph. 60 kV electrons. Magnification 6,500 ×.

Figure 9. Micrograph of portion of trachea from mosquito adult. Central part of picture dirty. Note some of taenidia are rings instead of helices. 60 kV electrons. Magnification 2,720 ×.



5 μ
4
1 μ
6
1 μ
5
1 μ
7
1 μ
1 μ
1μ
8a
5
8b
9

PLATE X

Figure 10. Electron micrograph of portion of trachea of honey bee. 60 kV electrons. Magnification 16,000 ×.

Figure 11. Micrograph of small portion of another trachea of honey bee. 60 kV electrons. Magnification 25,500 ×.

Figure 12. Micrograph of small portion of wall of abdominal air-sac of honey bee. 60 kV electrons. Magnification 11,100 ×.

Figure 13. Micrograph of small portion of a large trachea of cockroach. The dark line on the left side is the edge of a tænidium (tænidia slightly more than 1 μ broad in this trachea). 60 kV electrons. Magnification 12,000 ×.

Figure 14. Micrograph of a small trachea of cockroach. Note tænidia as helices, incomplete rings and complete rings. 60 kV electrons. Magnification 12,000 ×.

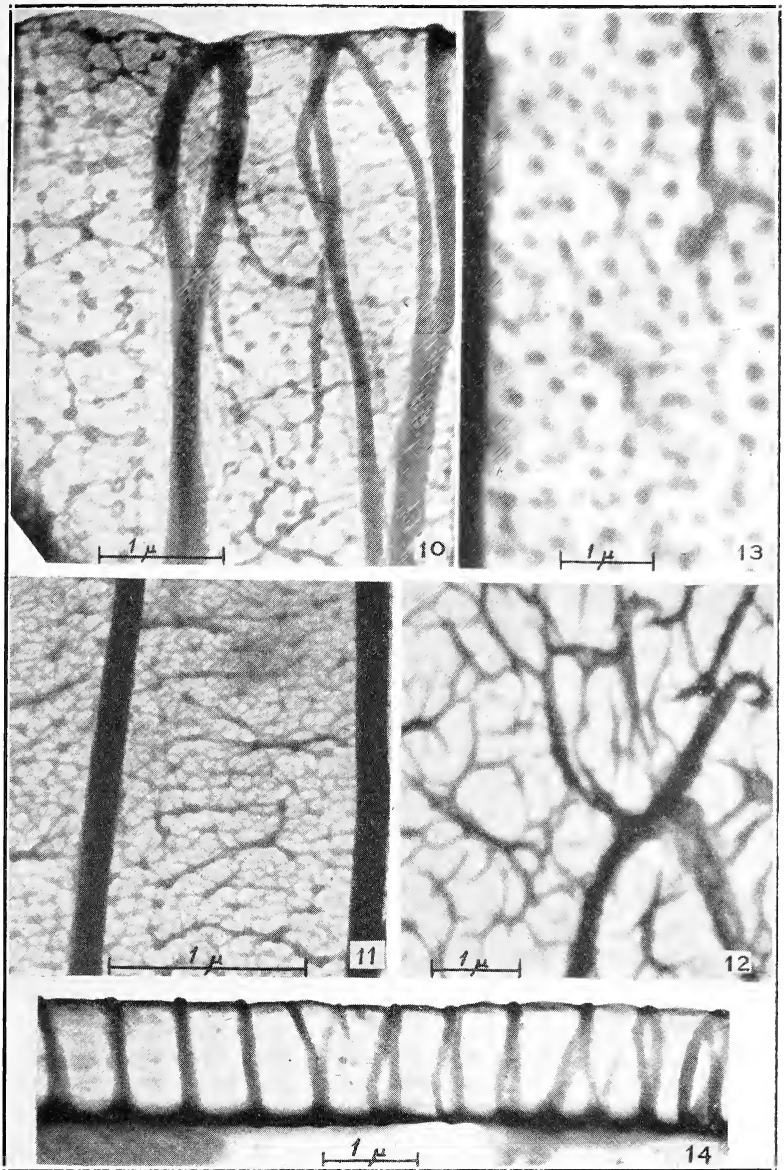
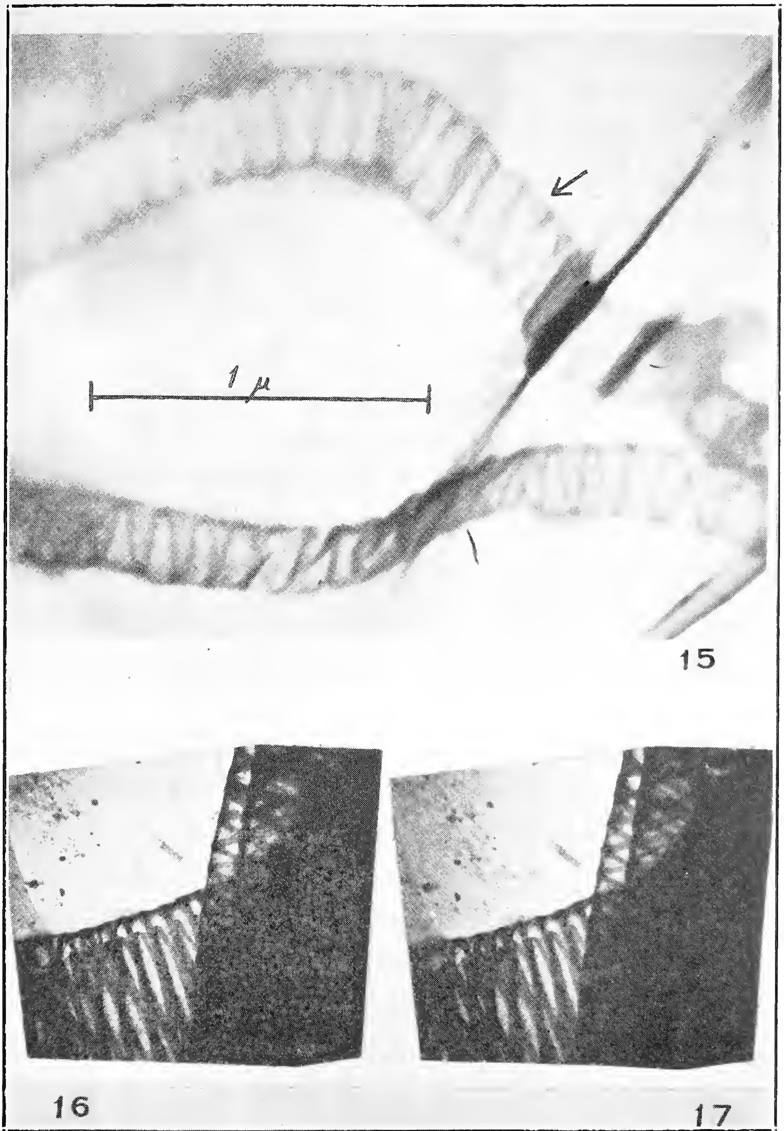

1 μ
10
1 μ
13
1 μ
11
1 μ
12
1 μ
14

Plate XI

Figure 15. Electron micrograph of tracheole of honey bee. This tracheole collapsed; its calculated diameter is less than 0.2 μ. The arrow points to double silhouette line where the thickness of the tracheole wall can be measured. 60 kV electrons. Magnification 44,400 ×.

Figure 16–17. Stereo electron micrographs of tracheæ from shed skin of third instar mosquito larva. These may be viewed directly with a stereopticon to show that one tube is inside the other. 60 kV electrons. Magnification 2,720 ×.



15

16

17

NOTES ON CICADAS WITH DESCRIPTIONS OF NEW SPECIES[1]

BY WILLIAM T. DAVIS
STATEN ISLAND, N. Y.

In the summer of 1941, Mr. and Mrs. J. N. Knull from the Department of Entomology, Ohio State University at Columbus went insect collecting and as usual found a considerable number of cicadas. In 1940 they collected some cicadas in Texas, and a few in Arizona and California, but in 1941 they again visited Southern California where there are probably more species of cicadas than in any other area of equal size in the United States. In an area about the size of the State of New York which contains eleven named forms they collected 187 specimens, of 29 species, some of them coming from nearby parts of Arizona. In Southern California, probably forty or more species can be found. Some of these appear to have but a very small area of distribution, as for instance the beautiful green and black *Okanagana nigriviridis* of which five were collected. Three *Okanagana opacipennis* were found, and it is the only species in the United States known to the writer in which the fore wings are wholly opaque. It and *Okanagana rubrovenosa* occur on the Manzanita bushes, where their red color blends well with the reddish bark. Four *Cacama californica* were taken, a welcome record, as but few have been examined.

These diligent collectors also found, as others have observed, that the small *Okanagana pallidula* after emerging from its pupa skin, which may remain in the burrow, will often also stay there for a time. It is certainly unique to hear a cicada singing from its burrow as do some species of crickets.

In 1892 Prof. P. R. Uhler named *Clidophelps blaisdelli*, and complained when describing the species, that: "specimens have

[1] I am indebted to Howard Cleaves and Mrs. Cleaves for drawing text figures and taking photographs and to Edward E. Hannigan for photographing two of the specimens.

thus far proved scarce.'' In 1926 the writer named *Clidophelps wrighti,* based on seven specimens. A few others have since been examined. It was a pleasant surprise therefore to find that Mr. and Mrs. Knull had collected no less than sixty *wrighti* at Jacumba and Oak Grove in San Diego County and at Cajon Pass in San Bernardino County. They also collected fourteen *blaisdelli* at Jacumba and Oak Grove. These two species live together, and it was of interest to find that this long series could be so readily separated by the structural and color differences mentioned in the original descriptions. Other species of *Clidophelps* were also collected, such as *vagans* and *tenuis.*

Tibicen curvispinosa and Tibicen nigroalbata

At the time of describing these remarkable insects in the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY, June, 1936, males only of *curvispinosa* from Mexico, and a female of *nigroalbata* collected by Prof. E. D. Ball in Santa Cruz County, Arizona, August 15, 1935, were available.

In 1940, Mr. Albert E. Maas sent three females and seven males of *curvispinosa* taken at Compostela, Nayarit, Mexico, in June and early July of that year.

On July 12–13, 1940, the field expedition from the University of Kansas was at Ruby, Santa Cruz County, Arizona and was fortunate in collecting four males and a female of the much desired *Tibicen nigroalbata.* At the suggestion of Dr. Raymond H. Beamer, that one of the four males be designated as allotype, I have selected the one collected at Ruby, Santa Cruz County, Arizona, July 12, 1940 (R. H. Beamer), and now in the collection of the University of Kansas. In sending the specimens for inspection, Dr. Beamer wrote: ''They were about as difficult to take as any Cicada I can remember. We had heard them, one here and there, for several days before we finally captured a pair. Then we took the other three the next morning as we were leaving. They were not numerous, and the region was rough and the going hard. It took the whole party to get the three specimens, about that many hours.''

The five specimens of *nigroalbata* mentioned above are from about the same part of Santa Cruz County where the type was

collected by Dr. Ball in 1935, and like it they all have the tergum shining black. The twenty specimens of *curvispinosa* so far examined from Mexico, collected about seven or eigth hundred miles further south, are much paler in color and have the abdominal segments greenish brown, or with only about the basal half of each segment black in color. Also they have that portion of segment two at the base of the abdomen and the broad tympanal plates or covers, brown in color, except for the pruinose spot, whereas in *nigroalbata* the covers are black except for the pruinose spot. The males of *nigroalbata* have, as in *curvispinosa,* a long, slim upturned spine protruding backward from segment IX, as illustrated in the 1936 description, and it is possible that it is a northern race of the paler colored *curvispinosa.* Specimens from northern Mexico are desirable, as well as observations on the habits and songs of the two insects.

It may be of interest to refer to some of the specimens of *Tibicen curvispinosa* in the U. S. National Museum, and the opinions held concerning them by several entomologists. In: "Studies in Certain Cicada Species," Entomological News, April, 1907, p. 128, Prof. John B. Smith and John A. Grossbeck, refer to this species as follows: "Plate III, figures 7 and 8, illustrate the genitalia of a Mexican species of Cicada, which we have not attempted to identify and present merely to show the variation of the structure in the genus. The specimens were sent from the U. S. N. M., with the *tibicen,* and were labeled *C. opercularis* Oliv., which of course they are not. It probably represents a new species."

In 1938 four males of *curvispinosa* were sent to the writer for examination and among them the specimen mentioned above labeled: *C. opercularis* Olivier, and collected at Guanajuato, south central Mexico by A. Duges. Another male bears no specific name, but was collected by A. Duges at the same locality. A third male, also from Guanajuato, is labeled "*Cicada rudis*" on one label and on another label, "*Rihana* (*Cicada*) *rudis* Walker O. H. A fourth male came from Guadalajara, Jalisco State, Mexico, July 1885. Some of these specimens once formed a part of the P. R. Uhler collection.

As *Tibicen curvispinosa* in appearance very closely resembles

T. rudis Walker, as will be noted by consulting Distant's colored figure of *rudis* in "Biologica Centrali-Americana, Rhynchota-Homoptera," it is not surprising that Mr. Otto Heidemann of the U. S. National Museum, identified one of the males from Guanajuato as *rudis*. He was unfamiliar with the great differences in the genitalia between the two species, and also of the presence of the two remarkable spines at the end of the abdomen in what is now known as *curvispinosa*.

Tibicen longiopercula Davis

This species was described and figured in the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY, for June, 1926, from a male in the collection of the U. S. National Museum, collected in the Chiricahua Mts., Cochise County, Arizona, June 10, by H. S. Hubbard. It was stated that "The long opercula, which almost completely cover the underside of the abdomen are conspicuously reddish and shining, especially near the extremities."

Lately Dr. Raymond H. Beamer of the University of Kansas sent for examination a male of this species collected by him in Sunnyside Canyon, Huachuca Mts., Arizona, July 9, 1940. A male collected by Dr. E. R. Tinkham in the Santa Rita Mts., Arizona, June 16, 1940, 6,500 ft., has also been examined. These are the only specimens known to the writer, and more are certainly desirable, for the long opercula probably vary considerably in length.

Diceroprocta apache and its varieties

Diceroprocta apache was described and figured in the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY, for March, 1921, from Florence, Arizona. They were found on mesquite, and Dr. H. H. Knight described their song as continuous, even toned and moderately shrill. It was stated that there were "several color varieties of *apache*, the commonest one having the body mostly brown or brownish, instead of black" or nearly black, as in the typical specimens from Florence. The collar is always pale.

In this JOURNAL for September, 1930, Dr. R. H. Beamer in his: "Biological Notes on Some Western Cicadas," collected in 1929, makes the following interesting observations: "*D. apache* Davis

was common over large areas and occurred in a great variety of habitats, all of which were of low altitude. A number of males were heard singing in willow at eight P.M., June 30, at the bottom of the Grand Canyon. Only one was taken. A large brood occurred near Wickenburg, Arizona, July 2, in a habitat almost exclusively Palo Verde trees. Phoenix was noisy with their songs at half past six in the evening and again at ten in the morning. Near Yuma the party was welcomed when it arrived at half past seven P.M. (Rocky Mountain time), for all along the Colorado River and the irrigated section west of the river there were myriads of these noisy friends. Even in the Salton Sea valley, ***D. apache*** was busy singing at eight P.M., July 28, and again at seven the next morning. Exuvia clung to the wire netting around the government laboratory in Coachella. Nests of eggs were found in sunflower stalks nearby. Hundreds of adults were living in a citrus orchard a few miles north of town. As many as twenty were found in one tree. In a little group of mesquite trees a mile farther north, numbers were picked off the limbs with the fingers. Here large cicada killers were at work but eluded the collectors. The nests in sunflower stems were placed in a straight line, from two to sixteen in a series, so close together that one extends to the next. Nine or ten large eggs were placed in mismatched pairs down the stem from the nest opening. Seventy-four males and twenty-four females were taken.''

An account of our personal observations on *apache* at Indio, California, in late June, 1931, is given in this Journal, for June, 1932, p. 248, and it is stated that the majority of the specimens found were of the light brown variety, and that similar color forms had been examined from localities in Nevada and Utah. A few, however, were almost entirely black with the collar and wing veins straw-colored or even green. *Apache* is known to occur at Indio from June to October.

On June 26, 1931, Mr. George P. Engelhardt and the writer found a number of *apache* on the bushes near the railroad station at Buckie, Arizona. They were of the typical dark form, as have been the considerable number since examined from the same locality secured by other collectors.

Apache has been thus far collected in Arizona, Utah, Nevada,

California, old Mexico, and reported from Texas. It varies considerably in color according to environment, as has been stated. In southern California, near the Salton Sea, in the Coachella Valley, in the Imperial Valley, as well as about Yuma, Arizona, the pale form predominates, black bodied or nearly black bodied specimens being much less common. The pale form also occurs along the Virgin River in southwestern Utah; along the same river as it flows southward to the Colorado through Clark County, Nevada, and Mr. Richard G. Dahl has found the pale form at Needles, California, on the Colorado River.

In showing me a very long series of typical *apache* collected by Messrs. Gertsch and Hook, 15 miles south of Chandler, Maricopa County, Arizona, July 16, 1940, Mr. M. A. Cazier, of the American Museum of Natural History, was struck by the great difference in color between them and the pale forms mentioned above. As the pale variety results from a different environment, he suggested that it be given a name.

Diceroprocta apache variety **ochroleuca,** new variety (Plate XII, Fig. 3)

Type male and allotype female from Indio, California, June 21, 1931 (Wm. T. Davis). Davis collection.

There are paratypes of *ochroleuca* in the writer's collection from Yuma, Arizona, but as the Gila River is ascended toward Palo Verde, Buckie, Phoenix, Tempe, Chandler, Sacaton, Florence (the type locality) and beyond to San Carlos, typical *apache* is usually the only form present. The same appears to be the case in ascending the Colorado River, and typical *apache* are to be found at the Grand Canyon. Dr. John W. Sugden collected dark colored *apache* along Rock Creek, Kane County, Utah, July 21, 1937. This creek flows into the Colorado. The dark form was collected at Yermo, San Bernardino County, California, about 80 miles west of the Colorado on June 4–9, 1940, by Mr. Richard G. Dahl, who reported them mostly on willow, but also on cottonwood, and singing loudly all day.

Diceroprocta semicincta variety **nigricans**

The species, *D. semicincta* Davis, was described and figured in the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY, March, 1925,

from Arizona, and again characterized in the JOURNAL for December, 1928. Several hundred specimens have been examined from Arizona, and it is now known to occur also in New Mexico and Mexico. The principal structural variation in the many specimens examined, has been in the shape of the pale straw-colored opercula, which may vary from a nearly triangular form, to having the apices drawn out and sometimes also in-curved. In a long series from some of the localities in southern Arizona both forms of opercula may be found, but there is a tendency toward the localization of the forms. Specimens thus far examined from Silver City, New Mexico, have the opercula triangular in shape and the apices not drawn out as is often the case in those from the Boboquivari Mountains to the west.

In the summer of 1941 the biological expedition of the University of Kansas visited a number of localities in Arizona, and among the many cicadas collected and kindly sent to me by Dr. Beamer, there was an almost wholly black form resembling *semicincta* but with several noticeably distinct features. Awaiting more specimens, it may at present be considered a variety of *semicincta*. It will be figured in a future article.

Diceroprocta semicincta var. **nigricans**, New Variety.

Type male, Chiricahua Mountains, southeastern Arizona, August 7, 1941 (L. H. Banker). Collection, University of Kansas.

Structurally closely related to *semicincta* to be found in the same mountains, but with a narrower head than *semicincta* specimens having an equal expanse of wings, and with the small opercula triangular in shape and barely covering the openings beneath. Body black above except the eighth abdominal segment, which has the usual pruinose spot each side. The collar is entirely black with no indication of the pale hind margin present in *semicincta*. Venations of both pairs of wings black; basal membranes dark gray and basal area nearly all black with a small nearly round pellucid area at the outer lower margin. In *semicincta* this area is clear, except for the narrow dark line along the front margin. Beneath; legs black or nearly so (they are straw-colored in *semicincta*); opercula dark, clouded at base; abdominal segments pruinose at sides, and pruinose on the under side of head, pronotum and mesonotum.

MEASUREMENTS IN MILLIMETERS

	Male Type
Length of body	24
Width of head across eyes	9
Expanse of fore wings	71
Greatest width of fore wing	11
Width of operculum at base	5
Greatest length of operculum	5

After receiving the writer's report on the cicadas collected in 1941, Dr. Beamer wrote that Mrs. Beamer had recognized the pecularities of what is here called variety *nigricans* when the specimen was captured by Mr. Louis H. Banker, who climbed to the top of a tree to get it. "I am only sorry we did not stay in this spot longer," adds Dr. Beamer.

Diceroprocta tepicana Davis

This species was described and figured in the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY for September, 1938, from three specimens collected in May, 1937, near Compostela, Nayarit, Mexico. In 1938 Mr. Albert E. Maas collected eight males and two females of *tepicana* in June and early July at the type locality. The thirteen specimens in size and color closely resemble one another, and all are much larger than *Diceroprocta bakeri* Distant, and have more prominent eyes. There is, however, considerable resemblance in size and color between *tepicana* and *Ollanta mexicana* Distant. In the latter the tympanal orifices are partly exposed, whereas in *tepicana* they are completely covered. Also the inner pair of obconical marks on the pronotum are separated in *mexicana* and allied species, whereas in *tepicana* and its allies, they are contiguous at base.

A NEW CICADA OF THE *DICEROPROCTA SWALEI* GROUP

In the southwestern United States and in Mexico there are seven described species of yellowish brown cicadas, in which the veins surrounding the marginal areas of the fore wings are often infuscated. They are:

Diceroprocta swalei (Distant), 1904. Arizona
Diceroprocta swalei var. *castanea* (Davis), 1916. Arizona
Diceroprocta virgulata (Distant), 1904. Mexico

Diceroprocta bakeri (Distant), 1911. Mexico
Diceroprocta arizona (Davis), 1916. Arizona
Diceroprocta tepicana Davis, 1938. Mexico

The writer has specimens of all of these species, *virgulata* excepted, which is described as expanding: "59 millimeters and with opercula pale dull ochraceous their inner areas black." It is figured in Appendix, Biol. Centr.-Amer., 1905.

Among the cicadas collected on the Fourth Hoogstraal Mexican Biological Expedition, 1941, there are four small males belonging to this group from Apatzingan, State of Michoacan, Mexico, here described as a new species.

Diceroprocta pusilla new species (Plate XII, Fig. 4).

Type male from Apatzingan, Michoacan, Mexico. Alt. 1200 feet, August 10, 1941 (Ralph Haag). Davis collection.

Resembles *Diceroprocta bakeri* Distant, also from south central Mexico, but is smaller, is darker colored and has more prominent eyes. The opercula have the outer margins nearly parallel to each other, the inner angles almost touch; the extremities are obliquely rounded, and extend slightly beyond the base of the abdomen. When seen in profile the lower extremities of the uncus are noticeably long and claw-like when compared with allied species.

Head black, a small pale spot above each antenna, and one each side near the posterior margin. Pronotum ochraceous, a central longitudinal fascia, angularly dilated anteriorly and posteriorly; furrows black and the posterior

D. pusilla

margin or collar green or yellowish green. Mesonotum black, hind margin pale, the elevated X pale with a central black spot and a small black dot each side just before the anterior limbs of the X. The obconical areas extending backward from the fore margin with only the outer margins pale. Abdomen above black, the tympanal covers and the eighth segment paler, especially at the sides. Body beneath and legs almost entirely pale and pruinose, especially the opercula. Under side of the abdomen pruinose, with the segments light colored along their posterior margins. The basal membranes or

anal areas in both fore and hind wings grayish, with the veins surrounding the marginal areas ochraceous. Basal area nearly clear, and costal margin of fore wings greenish.

MEASUREMENTS IN MILLIMETERS

	Male Type
Length of body	14
Width of head across eyes	5.5
Expanse of fore wings	44
Greatest width of fore wing	6
Greatest length of operculum	4

In addition to the type two males were collected July 30, 1941, at Apatzingan on Acacia, and another male on August 10, 1941, amid semi-desert scrub.

Chinaria mexicana and an allied form

Chinaria mexicana was described and figured in the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY for March, 1934, the type locality being Cuernavaca, Morelos, Mexico. Since 1934 additional specimens have been received, and at present there are 9 males and 6 females in the writer's collection including the type and allotype. They are from the states of Sinaloa, Nayarit, Michoacan and Morelos, all on the west coast of Mexico excepting Morelos, which is about 150 miles inland. Adjoining and to the southwest of Morelos, and on the coast, is the State of Guerrero, where 7 specimens of what appeared at first to be *mexicana* were collected in August, 1938, by Mr. Louis J. Lipovsky. The size and rather complicated wing pattern of all of the specimens is as in *mexicana,* but the uncus shows considerable difference in form indicating a separate species or geographic race. The original illustrations of the type and the uncus of *mexicana* are here reproduced for comparison with what is here described as *Chinaria similis.*

Chinaria similis new species (Plate XIII, Fig. 2).

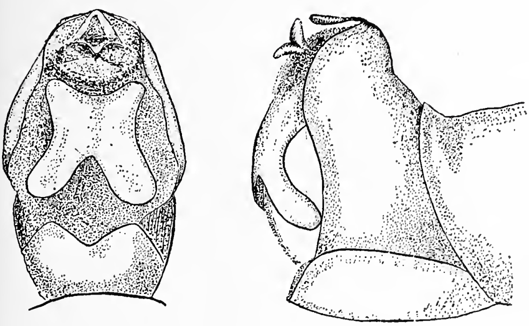
Type male and allotype female from Tierra Colorado, Guerrero, Mexico, August 15, 1938 (Louis J. Lipovsky). Davis collection.

Resembles *Chinaria mexicana* in size and in wing maculation.

Head narrower than in *mexicana,* front rounded, lateral margins of the pronotum considerably dilated and with the outer angles prominent. Rostrum extending beyond the posterior coxæ. Opercula very short and rounded, the

inner extremities far apart. Last ventral segment not quite evenly rounded at the extremity; in the allotype there is a small notch. The abdominal walls are very thin in the males, especially beneath, as they are in *mexicana.* Uncus as figured.

Color greenish, with the tergum of abdomen somewhat yellowish; wings much spotted with brown as in *mexicana,* and as illustrated. Head greenish, black about the ocelli, and four dots near the posterior margin between the eyes, the outer two being the larger. Pronotum green, including the collar, with the grooves darkened. There are two almost parallel lines centrally extending from the front margin of the pronotum backward between which is included a long and narrow irregular yellowish spot. Mesonotum with four spots extending backward from the front margin, the inner pair the



CHINARIA MEXICANA

Chinaria similis

shorter. The cruciform elevation or X, is green with a small dark spot each side near the anterior limbs. Abdomen nearly uniform yellowish green in type, but in some of the paratypes segment eight is more or less pruinose. In the female allotype the tergum is darker with the hind margin of each segment slightly lighter in color, and with an indication of spots near the lateral margins. Under side uniformly pale with the central segments somewhat translucent. Some of the paratypes have the under side pruinose along the sides of the abdomen and about the legs. Wings marked with brown and as shown on the plate. In both *mexicana* and *similis* there are pale, irregular, whitish and bluish spots, more or less regularly distributed on the fore wings. In the radial cell the central portion of the included brown ring is bluish with a whitish spot outside at each end of the ring. The eighth marginal area of the fore wing also contains a rather large wedge-shaped white spot. These pale spots may not be detected unless the insect is held in a certain position.

MEASUREMENTS IN MILLIMETERS

	Male Type	Female Allotype
Length of body	34	27
Width of head across eyes	9	9
Expanse of fore wings	86	86
Greatest width of fore wing	12	12
Greatest width of operculum	5	......

In addition to the type and allotype, five males and one female are in the writer's collection all collected at the same place and date. The form of the uncus in *mexicana* and *similis* shows no intergrades in the available material.

Okanagana villosa Davis

This species was described and figured in the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY, March, 1941, from a single male type now in the University of California collection. It was collected at Cloud's Rest, 9,924 feet, Yosemite National Park, California, June 9, 1931.

Recently two additional males of this remarkably hairy cicada have been examined, both collected near the type locality in California. One is labeled: "Tuolumne River, Sierra Nevada Mts., Calif. Elevation 8,000 ft., July 11, 1922 (Victor Duran)," and the other, from the collection of Mr. M. A. Cazier, came from Mokolumne Peak, Calaveras County, California, July 27, 1935.

Okanagana occidentalis from northern California, Oregon, Washington, British Columbia and adjacent territory is also a hairy species, and small individuals may be confused with *villosa,* but in *occidentalis* the front of the head is more obtuse when seen in profile, and the lateral margins of the pronotum are black and not margined with orange as in *villosa.*

Okanagana rimosa (Say) and **Okanagana canadensis** (Provancher)

Both of these species are remarkable on account of their wide distribution, which extends from eastern Canada and the northeastern United States, westward to beyond the Rocky Mountains. In western North America, where there are many species of *Okanagana,* several extend northward to British Columbia, but do not come far eastward; several, however, reach Manitoba.

With this wide range, it is to be expected that *rimosa* and *canadensis* would present some variations, and from an examination of a great many specimens, it appears that a variety here considered as more closely related to *rimosa,* is to be found in Ohio, and probably in Pennsylvania and New York. More specimens are desirable. Both species sometimes occur in great numbers and have their brood years, as recorded in literature, but the length of their life cycle is not known.

O. rimosa and var. ohioensis

Okanagana rimosa var. **ohioensis,** new variety (Plate XIII, Figs. 3 and 4).

Type male, Geauga County, Ohio, May 30, 1941 (Charles A. Dambach), and allotype female, Burton, Geauga County, Ohio, June 5, 1938 (Charles A. Dambach). Both in the collection, Ohio State Museum, Columbus, Ohio.

Larger and more robust than is usual in either *rimosa* or *canadensis,* with the abdomen in the males broad, not as tapering, and with the sides noticeably parallel. Fore wings long and narrow, with the costal margin usually bent more than in *rimosa* and *canadensis.* The uncus when viewed in profile is blunt at the extremity, but varies in some of the paratypes. It is hairy and the entire insect is more so than is usual in *rimosa* or *canadensis.* Head slightly narrower than the pronotum at the anterior angles. Median sulcus of the front well defined with the sides nearly parallel. Body of the male type when viewed from above gradually broadening from the head to the middle of the abdomen, but in some of the paratypes the sides are more parallel. Last ventral segment of the type with the extremity rounded but not notched. Uncus as figured, and as mentioned above; valve quite hairy. Last ventral abdominal segment of the allotype broadly notched at the extremity, with the inner notch rather plainly indicated. Wing venation as in *rimosa,* and not as coarse and black as is usual in *canadensis.* Basal area of the fore wings at base, as well as the anal membranes bright orange in color.

Head black above with the supra-antennal plates pale and a short longitudinal pale line in the groove extending backward from the central ocellus.

In one of the paratypes this groove is black. Pronotum nearly black including lateral margins with a large irregular rust-colored area each side of the central groove. Collar pale; mesonotum black bordered on the sides and posteriorly with orange. The tips of the obconical central areas are orange, the elevated X, is orange centrally; the fore limbs including the two depressed areas also pale. Metanotum edged posteriorly with orange. Tergum black with the segments edged posteriorly with orange as is usual in *rimosa*. Uncus black; valve pale slightly darkened near the tip. Beneath, the legs are pale orange streaked with black and considerably blackened on the inner sides of the fore femora. The abdominal segments are black margined posteriorly with orange, and with a black spot on each segment at the sides.

MEASUREMENTS IN MILLIMETERS

	Male Type	Female Allotype
Length of body	26	24
Width of head across eyes	7	7
Expanse of fore wings	73	73
Greatest width of fore wing	10	11
Length of valve	5	......

I am indebted to Edward S. Thomas, Curator of Natural History, Ohio State Museum in Columbus, who kindly sent me the first specimens of this variety collected in 1938 and 1941 by Mr. Charles A. Dambach, who later also sent me a male and female collected in May, 1941. Recently I received for comparison from J. N. Knull, Curator of Insects, Ohio State University, a well developed and fully colored male labeled: "Cleveland, O., June 20, 1914 (J. L. King)." It is of the same size as the type, but more contrastingly colored. Mr. Thomas considers that this insect is not uncommon among the white pines and hemlocks in the hilly country in the northeastern part of Ohio.

Platypedia tomentosa new species (Plate XIII, Fig. 5).

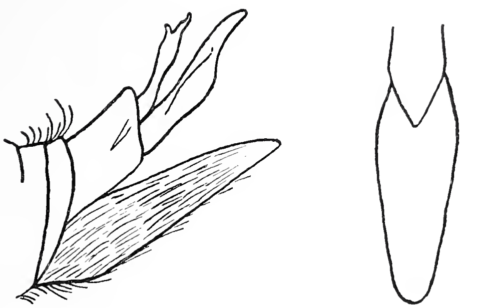
Type male, 7 mi. W. Coalinga, Fresno Co., California, March 20, 1940 (Richard G. Dahl). Davis collection.

Resembles *Platypedia scotti* in size and in having narrow fore wings, but is densely hairy and has a very differently shaped uncus. The uncus more nearly resembles that of *Platypedia balli* from Arizona, a larger and smoother species with a bluish tinge and not a brassy one. In *P. mariposa* the uncus is stouter; the insect is not tomentose and the membranes at the base of the fore wings are not as pale.

Head moderately broad with the front a little more prominent than in *scotti* and the face covered with rather long white hairs, more so than in

allied species. Uncus as figured and noticeably flattened at the extremity. Last ventral segment of the male rounded at the extremity, but obscured, as is the under side of the abdomen, by the abundant, matted, wooly hairs. Dorsal surface of the abdomen with many white hairs, especially at the base and on the sides. Basal area of the fore wings broader in proportion to its length than in most of the allied forms.

Body black with a slight brassy reflection especially on the head and pronotum. The usual pale spot above each antenna is greenish, and not orange as in allied species. Hind margin of the pronotum or collar pale



Platypedia tomentosa

green, and pale about the elevated X and in the hind margin of the mesonotum. Abdomen, uncus and valve black, both above and beneath. Fore legs with the front femora slightly chestnut colored on the sides; extremities pale, and tibiæ black. The middle and hind legs have the femora black above, pale beneath and at the extremities, while the tibiæ are pale centrally and darker at the extremities. Basal membranes of all of the wings almost white.

MEASUREMENTS IN MILLIMETERS

	Male Type
Length of body	20
Width of head across eyes	5
Expanse of fore wings	40
Greatest width of fore wing	7
Length of valve	4.5

In addition to the type, there is in the writer's collection a single male collected at the same place and date by Mr. Richard G. Dahl, who states that they were secured from *Juniperous californicus* by night beating, and that he heard none singing during the day time, although the temperature was about 78° F. The altitude was about 400 feet.

PLATE XII

Figure 1. *Tibicen nigroalbata.* Male.
Figure 2. *Tibicen curvispinosa.* Female.
Figure 3. *Diceroprocta apache* var. *ochroleuca.* Type.
Figure 4. *Diceroprocta pusilla.* Type.

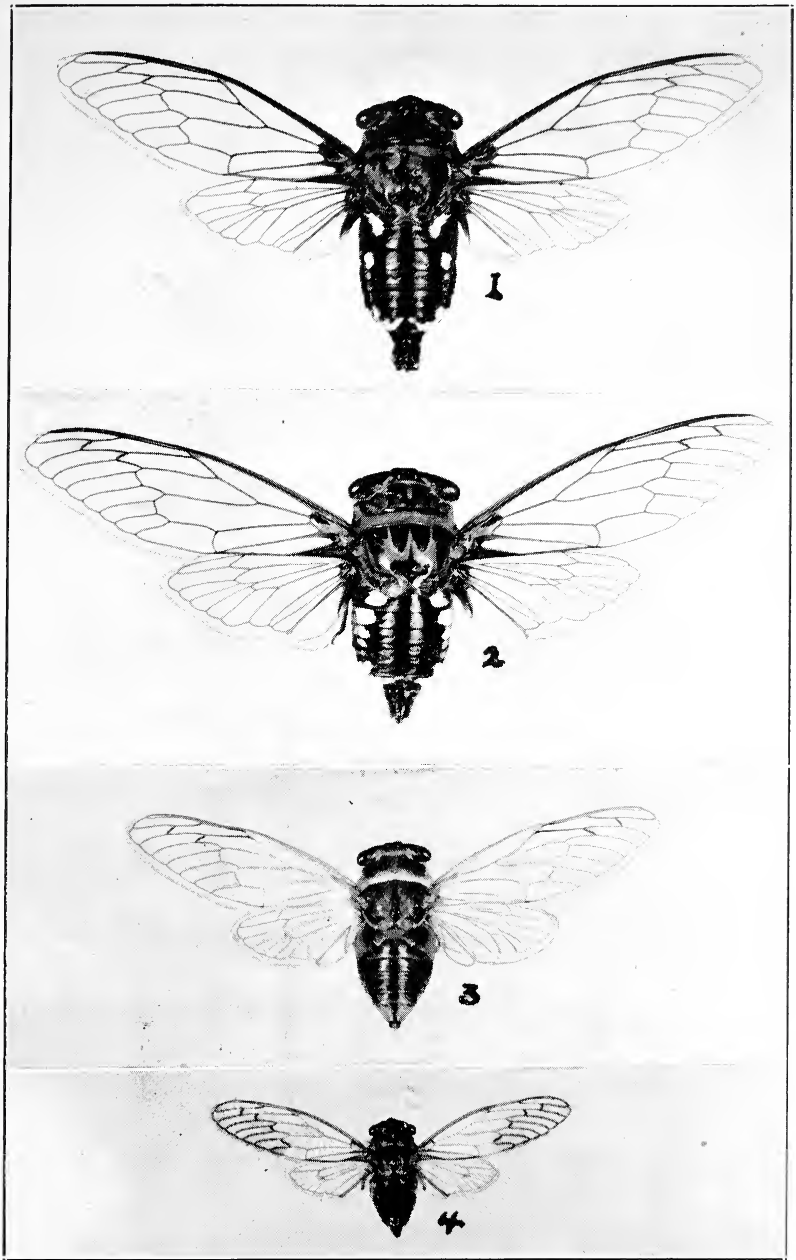

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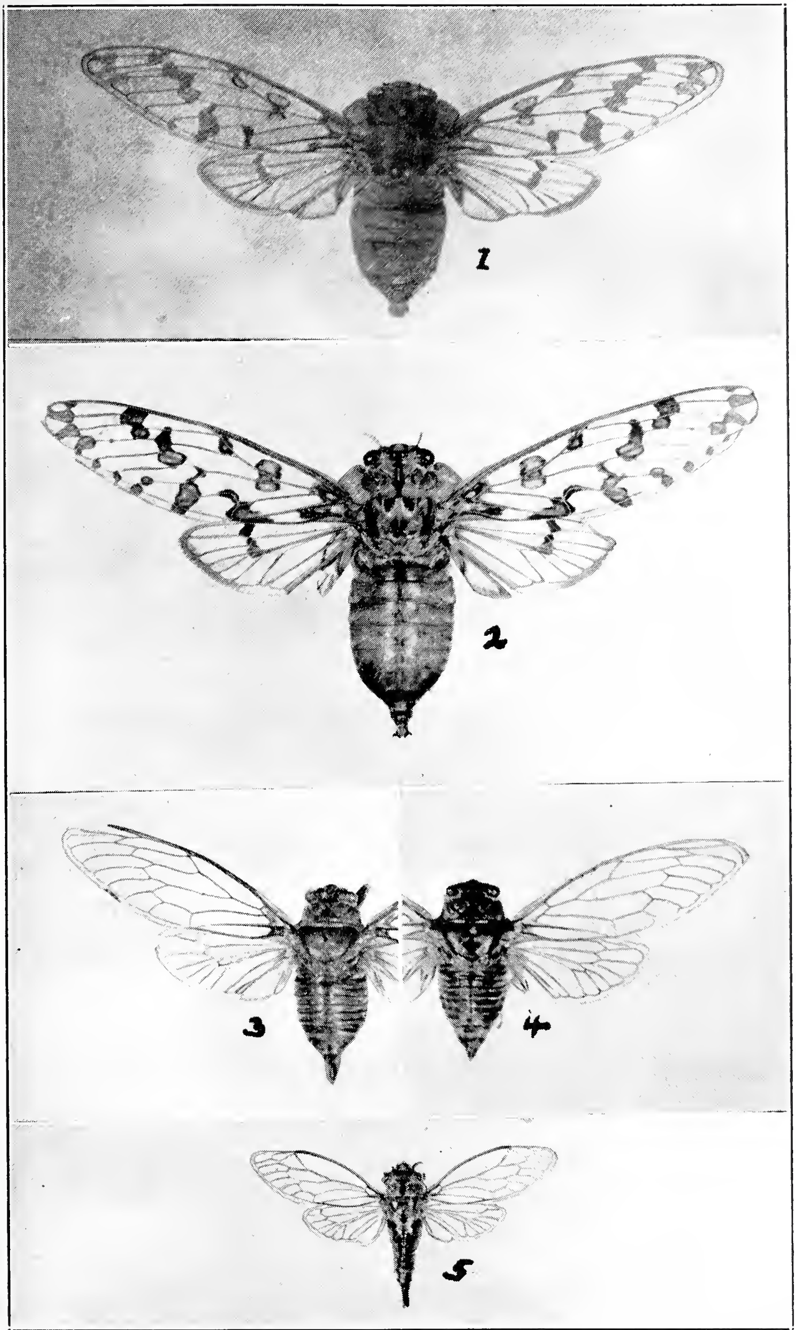
PLATE XIII

Figure 1. *Chinaria mexicana.* Type (reproduced).
Figure 2. *Chinaria similis.* Type.
Figure 3. *Okanagana rimosa* var. *ohioensis.* Type.
Figure 4. *Okanagana rimosa* var. *ohioensis.* Allotype.
Figure 5. *Platypedia tomentosa.* Type.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DATING THE SYSTEMA ENTOMOLOGIÆ, BY FABRICIUS AND PAPILLONS EXOTIQUES VOLUME I, BY CRAMER

By WILLIAM P. COMSTOCK

These two works were apparently published in the year 1775 but there is no definite evidence to show which appeared first.

Both Fabricius and Cramer, in their texts, refer very extensively to prior authors and both frequently cite Drury's second volume (1773), this being chronologically the last mentioned by either. This merely shows that both authors included the latest references available to them before completing their own manuscripts. Neither author cites the other.

An extensive examination of contemporary literature and bibliographies, and later works of reference, fails to produce evidence of value, with the exception of Sulzer whose references, though negative, are of interest.

"Dr. Sulzers Abgekürzte Geschichte der Insecten" I, 1776, with a dedication dated "Winterthur, den 2 Marz. 1776" and signed Joh. Heinrich Sulzer, contains in the preface a review of previous literature. On page XI, in a foot note, he says that in 1775 Cramer issued the first, second and third parts of his work, each part containing 12 plates. Thus Sulzer, at the time of writing his manuscript had seen only three parts of Cramer's work. On page XVII he gives a résumé of the Systema of Fabricius and on page XVIII, in a foot note, he quotes the full title of the work with the date 1775. It is evident that at the time of writing his manuscript, Sulzer had the complete work of Fabricius.

The date on the title page of volume I of Cramer is 1779, but the work is supposed to have appeared in parts in the years 1775 and 1776. The Catalogue of Books etc. of the British Museum, volume VI, supplement (1922) gives data taken from a copy of Cramer's work with the original wrappers in the Rothschild library. The listing for volume I is:

Parts 1–7; i–xxx, 1–16, 1–132, pls. 1–84, 1775.

Part 8; 133–155, pls. 85–96, 1776.

From this wrapper dating it has been assumed that the first seven parts of volume I appeared in 1775 but the evidence from Sulzer introduces a doubt for he mentions only three parts or 36 plates up to March 2nd 1776.

There is internal evidence to show that Cramer was working on his manuscript during the year 1774 for on page XXVII of his dedication he mentions Drury, 1771 (the first volume) and then "l'année derniere, d'un second tome" refering to Drury's second volume (1773). Further the dedication is dated on page XXX: "Amsteldam ce 2 Decembre 1774."

The date of the Systema Entomologiæ seems to be generally accepted as that of the title page, 1775, but there is an earlier date mentioned; that of the dedication on the following page: "Havniæ d. XXI. Nov. 1774."

It is my suggestion that the completed Fabrician work actually appeared very early in the year 1775.

I have been unable to find an actual proof of priority of publication of the work of Fabricius but the indications are in favor of it. If no other evidence[1] is later produced, I think that the slight priority of date in the Fabrician dedication, 21 November, 1774 over Cramer's dedication 2 December, 1774 may be used to fix priority.

A further fact, that carries considerable weight, is that the priority of the Systema over the first volume of Cramer is well established by usage. W. F. Kirby in his Synonymic Catalogue of Diurnal Lepidoptera (1871) consistently recognized this priority, placing many names appearing in Cramer's first volume as synonyms of names in the Systema of Fabricius. I am not aware that Kirby's action has ever been disputed on the ground of priority of the works.

PAPILIO LAVINA, FABRICIUS AND CRAMER

BY WILLIAM P. COMSTOCK

Papilio lavinia Cramer, (1775: I, 32, pl. 21, C, D) is a homonym of *Papilio lavinia* Fabricius, (1775: 450, No. 32) and the Cramer

[1] I have been unable to check one reference—J. Beckmann: Physikalisch-ökonomische Bibliothek, vols. 7 and 8 (23 vols., 1770–1806). A copy in the Library of Congress is at present unavailable.

name cannot be used. Forbes (1928: 305) says of it: "It was based on a specimen from Surinam, but it happens that Surinam is a meeting place of northern and southern forms, and typical *lavinia* is not typical of any of the well-marked races of the species. I suppose it should be used of one or another of the races, but it happens to be such an exact blend of the principal northern and southern forms that I am not using it as a subspecies name." Forbes places *oriana* Kirby (1894–1908: III, 24, pl. 51, fig. 3, 4) as the normal wet form in British and Dutch Guiana and says: ". . . my specimens show traces of green iridescence, and the original figure of *lavinia* shows fully developed iridescence, but has the pattern of this form, which perhaps should not be separated from *l. lavinia.*" The butterfly named *lavinia* by Cramer seems to be an aberration with an invalid name. A name for such a form is unnecessary and no new name need be selected.

As Forbes' use of *Precis lavinia* as a stem name is no longer tenable another name must be selected. The next available name is *Papilio evarete* Cramer (1779: III, 18, pl. 203, C, D) which Forbes places as an aberration of *lavinia.* The designation of *evarete* as the stem name of this group of *Precis* subspecies though unavoidable is undesirable, but it is certainly closer to the wide spread *zonalis.*

NOTE. After the proof had been returned I examined "The Auto-Biography of John Christian Fabricius" as tranlated from the Danish by Rev. F. W. Hope (1845–1847: Trans. Ent. Soc., London, i–xvi). Fabricius remarked: "In 1775, at Easter, during the great fair at Leipsig, my 'Systema Entomologiæ' appeared." This definitely dates that publication. W. P. Comstock.

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FABRICIUS, J. C. Systema Entomologiæ, 1775.

FORBES, W. T. M. Variation in *Junonia lavinia.* Jour. N. Y. Ent. Soc., XXXVI, 305–320, pl. 11. 1928.

KIRBY, W. F. Sammlung exotischer schmetterlinge, Neue englische Facsimile Ausgabe. Wytsman, I–III. 1894–1908.

BOOK NOTICE

College Entomology. By E. O. Essig. New York. The Macmillan Company, 1942. $9\frac{1}{4} \times 6$ in. viii + 900 p. 308 figs. $5.00.

This is a modern, well-written, text book on entomology for the use of students in colleges and universities. Separate chapters deal with the metamorphosis, the anatomy and the classification of insects. Of the remaining thirty-three chapters, each is devoted to an order of insects. The treatment of each order includes a general description of the characteristics of the order, descriptive text on habits, life cycles, etc., of its members, the basis for classification, a summary of the important external and internal anatomical characters of the adult, a summary of important larval characters, a list of the families, keys to suborders, superfamilies and to the more important families, descriptive accounts of family characters, habits and life-histories, and selected references. This treatment is modified in accordance with the importance of the orders and may either be restricted, or expanded to include keys to the larvae of important families, information on fossil history, castes of social insects, economic value of certain insects, etc. An extensive author and subject index is appended. The three hundred and eight figures are uniformly good.

The campodeids, iapygids and projapygids are the only groups remaining in the Linnæan order Aptera. The grylloblattids have been removed from the Orthoptera and placed in the order Grylloblattodea. Cockroaches, of the family Blattidæ formerly of the order Orthoptera, are now in the order Blattaria. The family Phasmidæ formerly of the Orthoptera is now the order Phasmida and the mantids are in the order Mantodea. The Diploglossata includes the hemimerids formerly in the Orthoptera. The name Embioptera has been followed for the embiids. The Megaloptera includes the Sialidæ and Corydalidæ and the name Raphidiodea is used for the Raphidiidæ and Inocelliidæ. Some of these changes were recommended years ago, but were not fully adopted in our text books. This excellent book maintains the high standard of Professor Essig's former writings.—H. B. W.

THE WING OF MASTOGENIUS (COLEOPTERA)*

BY WM. T. M. FORBES, CORNELL UNIVERSITY
ITHACA, NEW YORK

I recently reported on the genus Schizopus, a type which shows most of the superficial features of the Buprestidæ, with a wing like the Dascillidæ, and as has recently been published, a larva quite distinct from either. The present note is on a genus which shows a parallel anomaly; while the general structures are even more perfectly normal for the Buprestidæ, the wing is equally divergent, and again is of the type that I called Bostrychiform in 1926 (JOUR. N. Y. ENT. SOC., xxxiv, 95), though beyond fundamental folding type it has nothing in common with Schizopus.

The significant wing-features are the following: Pivot open to the costa (D) and replaced functionally by a secondary pivot (B) as in all Bostrychiformia; C and D represented by three folded areas (like Megatoma in the Dermestidæ and a few Bostrychidæ, but no other Coleoptera), S normal (unlike the Buprestidæ), H simple, not crossing Cu (normal for many Coleoptera, but excluding the majority of families that have a specially strong median "Strahlader"); jugal lobe with free tip (like many small beetles, but no Buprestidæ); B working with a triangular longitudinal fold in cell, which lies wholly above Mr (unique); Mr strong but Rr absent (like many Bostrychiformia and Haplogastra, but not the Buprestidæ); M strahlader present but radial absent (normal for Bostrychiformia), but connected to junction of Mr and Cu (unique).

This combination of characters is like nothing else known. It is utterly different from anything in the Buprestidæ, and has no special feature in common with Schizopus, but resembles several other families in one way or another, *e.g.*, the vertical area D marks the Sphindidæ, the triple hinge fold a couple of Bostrychidæ and one aberrant dermestid, the type of apical folding is shared by the Anthrenus group of Dermestidæ and the Cyphon group, though otherwise unique in the Coleoptera. A few fea-

* Family uncertain; formerly credited to the Buprestidæ.

tures, like the fold above Mr, the low attachment of the M strahlader, and the chitinization in fold D (which is not the vestige of the stigma, shown in this position by a very few Clavicorns) are absolutely unique. We must leave Mastogenius as an isolated

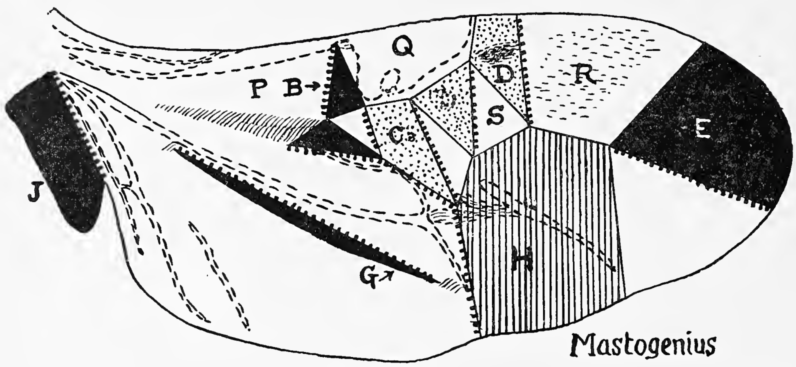

FIG. 1. The wing of Mastogenius.

relict-form, perhaps a direct descendant of the common ancestor of Bostrychoids and Buprestidæ, until we get further data. The discovery of the early stages or of annectant types may give us a clue some time.

NOTES ON THE GENUS SEIOPTERA KIRBY (OTITIDÆ, DIPTERA)

By Samuel C. Harriot

This study is based on material in the collections of the American Museum of Natural History, William Procter, Cornell University, and the California Academy of Sciences.

The genus contains three described species to which another is now added. The following key will help to separate them.

Table of Species

1. Costal cell hyaline or at most slightly yellowish as far as the humeral cross-vein 2
   Costal cell dark brown or blackish as far as and a little beyond the humeral cross-vein 3
2. Mesonotum with two narrow longitudinal whitish pollinose stripes; base and tip of the marginal cell dark brown........ *dubiosa* Johnson
   Mesonotum with just a trace of pollinose stripes at the anterior margin; only the extreme tip of the marginal cell brown........ *vibrans* Linnæus
3. Mesonotum with two narrow longitudinal pollinose stripes extending beyond the middle; wings hyaline; apical two or three segments of tarsi brown or black........ *colon* Loew
4. Mesonotum without pollinose stripes; wings with a yellowish tinge; tarsi completely pale yellowish........ *currani*, n. sp.

Seioptera vibrans Linnæus

1758. *Musca vibrans* Linnæus, Syst. Nat., 10 ed., p. 599.

This species, the type of the genus, was originally described from Europe. It occurs rather commonly in the Middle Atlantic States and New England, and has been recorded from Idaho, Oregon and Canada. *Vibrans* is closely related to *colon* and the differences are discussed below.

Seioptera colon Loew

1867. *Seoptera colon* Loew, Berl. Zeitschr., vol. 11, p. 296, fig.
1873. *Seoptera colon* Loew, 'Mon. N. A. Dipt.,' pt. 3, p. 152, fig.

There are three somewhat faded specimens of this species, from the Osten Sacken collection, in the American Museum of Natural History. All three were collected in New York. They bear his

determination label and are part of the lot from which specimens were sent to Loew for examination. Loew also saw specimens from Illinois (Kennicott).

Loew states that the front of *colon* is wider than that of *vibrans;* that the two whitish stripes of the thorax in *colon,* although little apparent, can easily be traced beyond the middle of the dorsum while in *vibrans* it is with difficulty that their anterior end alone can be perceived; also that the costal cell of *colon* is blackish as far and even a little beyond the humeral cross-vein while in *vibrans* this cell is entirely hyaline as far as the extreme basis.

A comparison, by the writer, of over eighty specimens of *vibrans* with the three Osten Sacken specimens of *colon* shows the above differences to be constant. Several other differences based on the color of the abdomen and stigma, and shape of the apical spot, although more difficult to see, appear to be present.

Seioptera dubiosa Johnson

1921. *Seioptera dubiosa* Johnson, Occ. Papers Boston Soc. Nat. Hist., vol. 5, p. 15.

This species was described from a single female collected at Northeast Harbor, Maine. There is a female specimen in the collection of William Procter from Bar Harbor, Maine. This specimen appears to differ slightly from the type. Johnson, in his description, states that the thorax is brownish-black, shining, with two subdorsal pruinose stripes; humeri yellow. The mesonotum of the Procter specimen is shining black, however, the greater portion of the anterior margin, except between the stripes, as well as the ground color beneath the stripes is yellowish. The scutellum is more reddish than black.

The mesonotal stripes in *dubiosa* are farther apart than in *colon,* and more distinct. The front of *dubiosa* and the following species is wider than that of either *vibrans* or *colon,* the face is more concave and the arista more pubescent. In *vibrans* and *colon* the arista appears to be bare.

Seioptera currani new species

Related to *dubiosa* but differs in having a wholly shining black mesonotum without a trace of pollinose stripes, completely yellow tarsi, and lacks the brown spot at the base of the marginal cell. Length, exclusive of ovipositor, 5 mm.

Female.—Front reddish, opaque, the red color continued as an arch behind the black ocellar area; frontal orbits very narrowly pollinose on the lower half. Front as wide as the greatest width of either eye. Occiput shining black, more brownish below. Cheeks shining yellow, somewhat brownish posteriorly. Face concave, pale shining yellow, orbits broadly whitish pollinose. Antennæ reddish yellow, third segment rounded above; arista sparsely pubescent. Proboscis dark brown or black; palpi yellowish.

Thorax shining black, mesonotum without any trace of pollinose stripes.

Legs black, front and middle tibiæ brownish, tarsi yellow.

Wings hyaline with a yellowish tinge. Costa, above the stigma and apically, black; otherwise yellowish. Auxiliary vein, first longitudinal vein, and apices of second and third longitudinal veins black; other veins yellowish. Costal cell as far and a little beyond the humeral cross-vein, subcostal cell including the stigma, tip of the marginal, tip of the submarginal, and part of the tip of the posterior cell dark brown or black. Squamæ and halteres white.

Abdomen and ovipositor shining black.

Types.—Holotype, female, Tuxedo, New York, June 26, 1928 (C. H. Curran), in the collection of the American Museum of Natural History. Paratype, female, Ithaca, New York, June 1, 1913 (H. H. Knight), in the Cornell University collection.

FOR MORE CLARITY IN ENTOMOLOGICAL WRITING

By Osmond P. Breland
The University of Texas

The present short article deals with a fault in entomological writing about which the writer has thought for many months. Too many entomological papers are written in such a manner that only the specialist in the particular group under discussion will have the faintest idea as to what insects are being considered. The reason for this, of course, is that frequently only scientific names are used without any indication as to the order or family to which these insects belong.

This lack of clear definition in entomological writing expresses itself in two distinct but related ways: first, in the matter of improperly defined titles of papers; and second, in the use of unexplained scientific names in the body of the work.

The writer has read several times within the past few months quite worth-while articles in which facts of general biological interest were discussed. But alas, only scientific names were used. Thus, at the time of reading, the writer had no idea whether the author was discussing the biology of a rare species of caddis-fly, or, except for the fact that the paper was in an entomological journal, whether perchance the writer was elaborating upon the bionomics of the arctic snowshoe rabbit! The bored skeptic will probably think that anyone who is so ignorant should be put to the trouble of identifying such scientific names for himself. The writer has tried this method. Not only that, but he has spent hours tearing his hair while looking through book after book that failed to yield results. Perhaps the greatest offenders are those who deal with host and parasite relations, since at times a dozen or more hosts of a given parasite, embracing several orders, are listed by scientific name without any indication of the orders or families involved.

Considering the fact that there are several hundred thousand species of described insects, it seems somewhat optimistic to expect anyone to have a speaking acquaintance with even a majority

of these forms. Many of us who are interested in insect biology desire to learn something of the work within groups in which we are not specializing. Yet we enjoy knowing what insect is involved without having to scrutinize several volumes in order to find out. There are also other biological workers who, although not essentially entomologists, are becoming increasingly interested in insects. It is certainly not encouraging to these men when they look through an entomological journal, to find that too often their eyes meet only horrible scientific names not adequately explained.

It seems to the writer that perhaps many workers are prone to write only for those men either in their own particular field, or for those who are working with the particular group of insects in which they themselves are interested. While the indiscriminate use of scientific names might, in a measure, be justified from this standpoint, the author should be optimistic enough to believe that perhaps other biologists might likewise be interested in the article. This type of writing is quite definitely not encouraging to the beginner in a particular field who has started to become acquainted with his subject.

In all fairness to modern writers, it should be said that, on an average, they are much clearer in this connection than were the writers of a half century or so ago. Many of these venerable old gentlemen helped to confuse the issue by writing descriptions of new species in Latin! Some journals publish better articles in this respect than do others, so that in some publications perhaps half or even more of the titles will indicate clearly what family or order is involved in the particular paper.

One additional reason why writers should clarify their publications applies to workers in the future. As the years pass, many of the scientific names that are accepted today, will fall into synonomy and, consequently, those names will drop out of the literature except for their occasional appearance in monographs of the groups concerned. This fact will, of course, add a double burden to future workers who are attempting to work out synonomy, or who are dealing with the biology of a certain group.

Needless to say entomological writing is not the only field that is cursed with inadequately explained articles. There is practi-

cally no scientific writing that would not benefit by clarification in some respects.

The writer believes that these difficulties can be obviated in great measure if authors will follow two very simple rules:

1. Make titles as clear as possible. This can be done in some cases quite easily. If only one or two species are being discussed, the order and family of the insects involved, should be added in parentheses after the title proper. If the paper deals with a number of species, including several families or orders, obviously this would not be possible. Rule number 2 is especially suggested for such papers.

2. The first time the scientific name of a species is used in an article, the family name of the species should be appended in parentheses.

It seems to the writer that entomology in general would profit if journals would adopt the above two regulations as requirements for all articles that are published. The writer feels that if authors would follow these two simple rules wider reading in entomology would be stimulated. It would also doubtless help to dissipate the commonly held opinion that an entomologist is a species of animal, wearing spectacles and a beard, that indiscriminately spouts scientific names.

ABDOMINAL GLANDS OF HESPERIINÆ

BY V. G. DETHIER
JOHN CARROLL UNIVERSITY, CLEVELAND, OHIO

To the lengthy list of ectodermal glands found in insects should be added the ventral abdominal glands of certain Hesperiinæ. These are of interest not only because of the large volume and peculiar properties of their secretion but also because of the importance of this secretion during pupation. Many workers (*e.g.*, Tutt, 1905–1906, 1908–1909; Sulc, 1924; and Comstock, 1934) had observed conspicuous white patches on the underside of fully grown larvæ, but the exact origin and nature of these had not been demonstrated.

MATERIAL AND METHODS

Larvæ of all instars of *Calpodes ethlius* Cram., *Panoquina sylvicola* H.-S., *Lerodea tripunctus* H.-S., and *Polites themistocles* Latr., (Hesperiinæ) and of *Erynnis icelus* Scud. & Burg. and *Thorybes pylades* Scud., (Pyrginæ) were killed and fixed in Bouin's solution. Tissues embedded in paraffin were cut serially at 5 microns. Celloidin serial sections were cut at 25 microns. Sagittal and cross sections of the abdomen were stained with Delafield's hematoxylin and eosin, Mallory's triple connective-tissue stain, or Heidenhain's hematoxylin.

Limited amounts of the secretion were subjected to microchemical analysis and microscopic examination.

OBSERVATIONS

In view of the volume of substance secreted, the simplicity of the active gland is unusual. Four large rectangular areas composed of simple unicellular glands and located on the ventral surface of the seventh and eighth abdominal segments of larvæ belonging to the subfamily Hesperiinæ constitute the entire secretory apparatus. Each area extends from the sub-ventral fold medially to the para-ventral line (Fig. 1) and may extend the length of the segment. No external structural modifications

of the cuticle exist. Beneath the cuticle in these regions the cells of the hypodermis represent a specialized type which exhibits a gradual transition at the periphery of the glandular area from the usual squamous or cuboidal hypodermal cells to simple columnar epithelium.

Viewed from the surface the gland cells appear as irregular

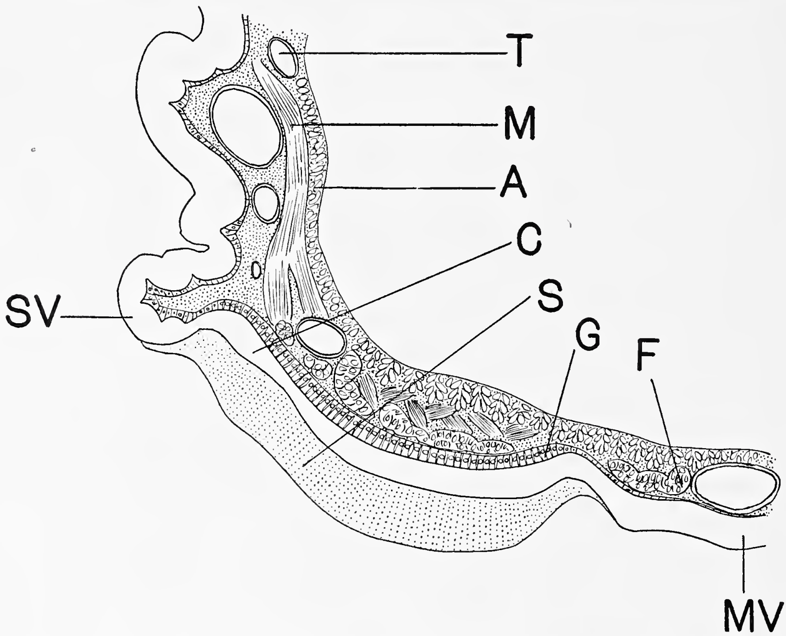

FIG. 1. Semi-diagrammatic drawing of a transverse section through the eighth abdominal segment of a larva of *Panoquina sylvicola*. Only the left half of the section is shown. T, trachea; M, muscle; A, lining of alimentary canal; C, cuticle; S, secretion; G, glandular area; F, fat body; SV, subventral fold; MV, mid-ventral line.

polygons (Plate XIV, Fig. 1). That this approximates their true shape and is not a result of distortion is evidenced by the fact that the corresponding epicuticular pattern is similarly designed. The hourglass contours of the cells seen in longitudinal section may be due in part to shrinkage. Except in the transitional areas the cells are from 3 to 5 microns tall and approximately 1.5 microns in diameter. Adjacent hypodermal cells are 1 micron on a side. At the free surface lies a well-defined striated border in contact

with the overlying endocuticle. Proximally there is a conspicuous refractive basement membrane. Distally the cytoplasm appears homogenous or finely granular though it stains more heavily with eosin than do surrounding tissues and may contain a few small vacuoles. In the basal region, however, between the nucleus and the basement membrane, the cytoplasm presents a peculiar coarse fibrous appearance. Here thick irregular fibers or cords which are highly refractive lie parallel to the long axis of the cell. In cross section they resemble myofibrils in vertebrate cardiac muscle.

The ovoid to spherical nucleus lies in the basal half of the cell. It is approximately 0.9 micron in diameter and is enclosed in a delicate nuclear membrane. Characteristic are its large spherical refringent granules. These are not seen in the nuclei of adjacent undifferentiated hypodermal cells. There is no indication of the presence of intracellular ducts or pores opening to the outside. Apparently the cells secrete directly through the overlying cuticle although it is no thinner here than above the non-secretory parts of the hypodermis.

Although the abdominal glandular areas are present in third and fourth instar larvæ, they do not become active until the fully grown larva is ready to construct a nest in which to pupate. At this time a copious white secretion appears on the overlying cuticle. Seen microscopically it is asbestos-like in structure, the threads of which it is composed lying perpendicular to the body surface.

The very small amount of material available rendered even a micro-chemical analysis difficult. While it is not possible at this time to make any statements regarding the chemical composition or structure, some of the properties may be listed.

The secretion is an amorphous material melting at 80–90 degrees C. This melting point is by no means sharp, and some decomposition takes place. Fresh material is insoluble in water, acetone, xylol, ether, chloroform, alcohols, concentrated and dilute inorganic acids, concentrated and dilute NaOH and KOH. In warm KOH it is slightly soluble while in warm H_2SO_4 it chars. No color reaction occurs in a test with HNO_3 for proteins, and ordinary histological dyes leave it unstained. It is a hydrofuge substance and can be wetted only by organic solvents.

There can be little doubt that the chief purpose of this material is to discourage the accumulation of water in the cocoon and wetting of the chrysalis. Larvæ of the Hesperiinæ construct loose cocoons in such a manner that unless precautions are taken, respiratory requirements of the chrysalis may not be met following rain or heavy dew. Pupation takes place, in most cases, on an upright blade of grass the edges of which have been drawn together. Rain and dew, especially in the tropics, tend to collect here. No more efficient method of nullifying this condition could be found than that of covering the chrysalis and lining the cocoon with a hydrophobe secretion. Adequate dispersal of the secretion is assured by the writhing of the insect prior to and following the last larval ecdysis. Spreading is further aided by the tendency of the fibers to separate and scatter on contact with water. Thus when water strikes the chrysalis, it forms small glistening drops which run off immediately.

Ventral abdominal glands for the production of hydrofuge materials are of most widespread occurrence in larvæ of the subfamily Hesperiinæ. No similar structures were found in the species of Pyrginæ examined. They or similar glands, however, occur sporadically in other related groups as for example in species of *Megathymus* (Megathymidæ). Here the secretion apparently serves the same purpose in that it water-proofs the burrow in which the larvæ of this family pupate.

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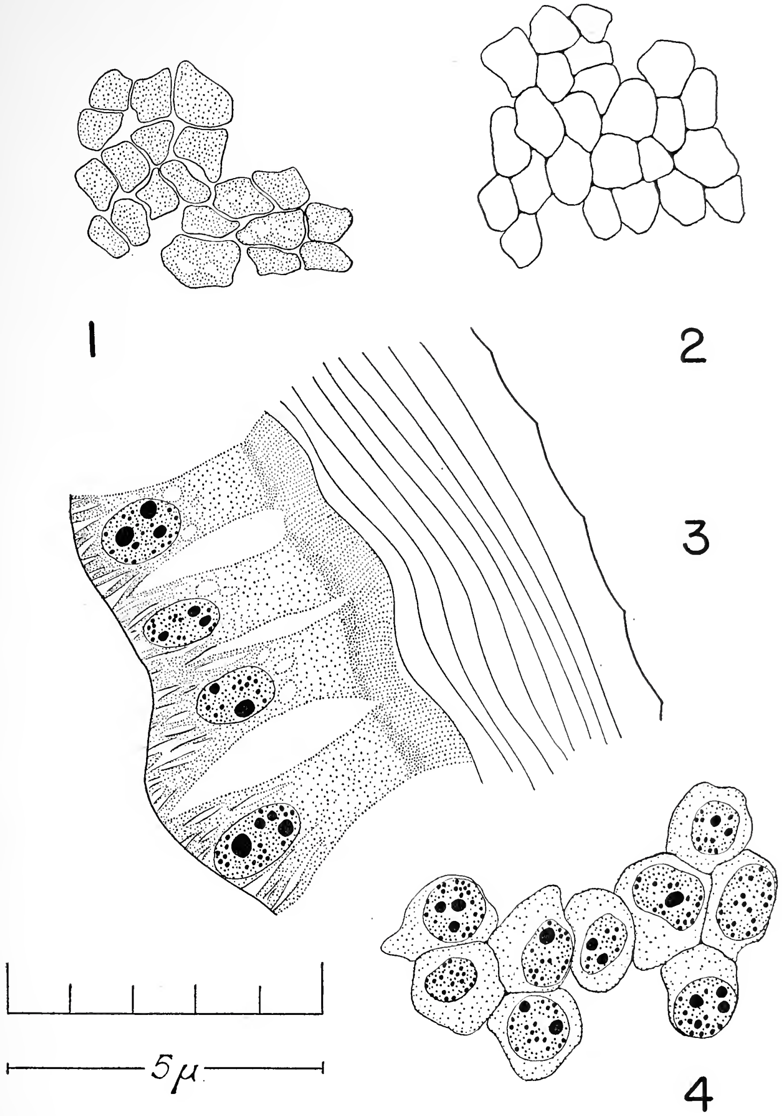
PLATE XIV

Figure 1. Transverse section through a group of gland cells just proximal to the striated border.

Figure 2. Surface pattern of overlying epicuticle.

Figure 3. Longitudinal section of several gland cells.

Figure 4. Transverse section through the nuclei of a group of gland cells.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IN MEMORY OF CHARLES SCHAEFFER. COMPILED FROM MEMORANDA FOUND AMONG THE PAPERS OF THE LATE CHARLES W. LENG

BY WM. T. DAVIS

As about eight years have elapsed since the death of Charles Schaeffer, it seems appropriate that a tribute to his memory should appear in the Journal of this Society which he served so long and well. He not only served on numerous committees, but also as Recording Secretary, Librarian and from 1912 to 1919 he was Editor of the Journal.

Charles Frederick August Schaeffer was born in London, England, on July 12, 1860, of German parents. His education was completed in Germany in 1876. For several years thereafter his entomological talent was unknown until his acquaintance with Gustav Beyer, Ottomar Dietz, and Charles Tuneson brought it to light about 1889. In 1892 the New York Entomological Society was organized, with Mr. Schaeffer as one of its first members. He was destined to serve it in various capacities for thirty-five years.

Mr. Schaeffer's professional career began in 1898 as assistant to William Beutenmuller in the American Museum of Natural History. There he remained for four years. In 1902 he joined the staff of the Brooklyn Institute of Arts and Sciences as curator of Coleoptera, in which position he remained, happily and usefully employed until his death, following a long illness, on August 29, 1934. In the early part of this period, 1902 to 1905, he made collecting trips to Mt. Mitchell, N. C., to Brownsville and vicinity in Texas, and to the Huachuca Mountains in Arizona. As a result of these trips and of studies extending over several years, Mr. Schaeffer was able to make notable additions to our knowledge of the subtropical fauna which earned for his ability recognition here and abroad.

During his later years he was occupied principally with the study of the Chrysomelidæ, in which the same painstaking dis-

crimination was manifest. The genus **Donacia** was for about five years constantly under investigation and eventually became the subject of a comprehensive review.

Mr. Schaeffer's work throughout dealt particularly with species and genera, in the recognition of which, whether previously described or new to science, he displayed unusual accuracy of observation. In making identifications for the younger entomologists who visited the museum, he was always helpful in this respect; and in acknowledgment of the gifts received from other collectors, always thoughtful.

Mr. Schaeffer was happily married, though his wife Maria unfortunately died some years before him. He left a son Charles L., and a daughter Mrs. Ernestine A. Rose, of Oradell, N. J., by whom his personal collection was sold. The greater part of his types, it is understood, will be eventually placed in the U. S. National Museum.

After an acquaintance of a quarter of a century it may be permissible to recall his general disposition, his many kind deeds, his confidence in his own identification, exhibited once in the famous sentence, "even I can make a mistake," mingled with more personal recollections of his devotion to coffee, his oft repeated tales of Esperanca Ranch, and his dread that he might "commit a synonym," which indeed he seldom did.

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Meeting of October 7, 1941

Former President Ruckes in the chair, twenty members and visitors present.

Mr. J. B. Ziegler, Jr., 1250 Fulton Street, Rahway, New Jersey, was proposed for membership by Mr. Comstock.

It was moved that a letter of cheer be sent to President Kisliuk who, because of illness, was not able to attend the meetings for the rest of this year.

Mr. Comstock and Mr. Davis spoke of Mr. Frederick Lemmer of Lakehurst, New Jersey, who died last week.

Among the visitors present were Mr. George C. Furness of the National Carbon Company, and Mr. Charles T. Ramsden from Santiago de Cuba.

There were many reports of summer collecting experiences. Mr. Davis showed a box of Brood XV of the seventeen-year locust. This is one of the smallest broods, but he had specimens of the 1890, 1907, 1929 and 1941 emergences. Dr. and Mrs. Argo were in the state of Washington during the summer, and Dr. and Mrs. Klots were in Arizona and New Mexico. There were several interesting records of Lepidoptera taken by members; these will be published elsewhere in the Journal.

The meeting closed with a discussion of insect migration.

Meeting of October 21, 1941

Vice-president Weiss in the chair, twenty-five members and visitors present.

Mr. J. B. Ziegler was elected to membership.

Among the visitors present were Mr. and Mrs. Lawrence S. Dillon of the Reading Public Museum, and Mr. Andrew J. Mutchler.

Mr. Englehardt, mentioned two ways in which the Society could meet the pending increase in cost of publication—either by cutting down on the size of the Journal or by raising the subscription price. He suggested that the New York and the Brooklyn Entomological Societies get together and take similar action.

He also spoke of two forthcoming papers in ''Entomologica Americana,'' one by Mr. Helfer on buprestid beetles and one by Dr. Bequaert on bot-flies.

Mr. George G. Becker, Senior Entomologist in charge of the enforcement of plant quarantine, told of the work being done at the Plant Quarantine Inspection House at Hoboken. The methods of inspection and fumigation of plants were described and illustrated.

Meeting of November 18, 1941

President Kisliuk in the chair, thirty members and visitors present.

In regard to the probable increase in the price of publication, Mr. Engelhardt reported that the Brooklyn Entomological Society had raised the price of their Journal fifty cents a year.

Dr. Stanley Bromley of the Bartlett Tree Research Laboratories, Stamford, Connecticut, spoke on the Shade Tree Insects of 1941, illustrating his talk with kodachrome slides. An abstract is appended.

THE SHADE TREE INSECTS OF 1941

The Japanese Beetle, *Popillia japonica* Neum., was given a prominent position in Dr. Bromley's discussion where it was pointed out that this insect was on the increase in Connecticut. While the new milky disease appears promising, to date no natural agency of control has had appreciable effect in reducing the numbers of the Japanese beetle, although locally certain birds and mammals may be influential. Crows, skunks and moles are of the greatest value in this respect, while grackles, starlings, robins and pheasants all feed on beetle grubs. To secure adequate control, however, chemical means must be employed. Dr. Bromley pointed out that the beetle feeds in the north throughout the summer until the killing frosts of mid-October. There appears to be no Japanese Beetle "Cycle" such as characterizes the tent caterpillar.

Coleopterous borers, particularly bark beetles have increased of late in many places and this increase has been traced to favorable breeding conditions resulting from tree damage by the hurricane of 1938 and the ice storm of 1940 as well as other climatic or meteorological factors.

The European elm bark beetle (*Scolytus multistriatus* Marsh.), usually considered secondary, has by sheer force of numbers become a primary killer of elm wood independent of the Dutch Elm Disease.

The elm leaf beetle (*Galerucella xanthomelaena*) was more abundant and destructive in the northeast in 1941 than at any time since 1910.

The turpentine beetles (*Dendroctonus terebrans* Oliv. and *D. valens* Lec.) were more abundant and destructive than ever before to ornamental pitch pines on Cape Cod during 1941. Dr. Bromley also described tests that were conducted for the control of the relatively new but increasingly important Scotch pine weevil, *Hylobius radicis* Buchanan.

MEETING OF DECEMBER 2, 1941

Vice-president Weiss in the chair, forty-five members and visitors present.

Dr. Herbert Dalmat of Iowa State College, Ames, Iowa, was proposed for membership by Dr. Spieth.

Mr. Weiss read a letter from Science Press in which they regretted that printing prices would be increased for 1942. The question of whether to increase our subscription price for the JOURNAL or to decrease the number of pages was referred to the Executive Committee.

Mr. Ackermann of the Westinghouse Laboratory showed his method of mounting Lepidoptera between sheets of cellulose acetate.

Dr. A. Glenn Richards, Jr., of the University of Pennsylvania, spoke on "Electron Microscope Studies of Insect Cuticle and Trachaæ with a discussion of the application of electron optics to Entomology," illustrating his talk with lantern slides made from electron micrographs he had taken. An abstract is appended.

ELECTRON MICROSCOPE STUDIES OF INSECT CUTICLE

Electron micrographs of sections of cockroach cuticle show spiral pore canals, averaging 0.15 microns diameter, traversing the endo- and exocuticles.

These two layers are made up of laminæ consisting of alternate layers of chitin and a denser chitin-protein complex. The laminar structure disappears when the protein is removed chemically; these data agree with and amplify the x-ray diffraction studies of others. The epicuticle is approximately two microns thick; it splits into two layers in hot HNO_3; the outer layer is colorless, of the order of 0.01 microns thick, and decomposes in the electron beam; the inner layer is amber-colored and seemingly homogeneous. These two layers form a continuous sheet without resolvable structure or holes.

On the other hand micrographs of cuticle of mosquito larvæ show no pore canals. And the epicuticle, treated with hot HNO_3, remains as a single layer and is resistant to the electron beam. We suggest, therefore, that different compositions are indicated for the epicuticle of these two insects.

The relation of these findings to cuticle permeability was discussed briefly. Oils do not penetrate via the pore canals and so must penetrate through the chitin-protein framework.

Micrographs of insect tracheæ and butterfly scales were shown to illustrate the minute anatomical details to be found in insect material. Details certainly reach magnitudes of the order of 0.01 microns. The membrane lining tracheæ is only about 0.01 microns thick. Butterfly scales contain numerous minute details previously unsuspected.—A. GLENN RICHARDS, JR.

MEETING OF DECEMBER 16, 1941

Vice-president Weiss in the chair, twenty-three members and visitors present.

The report of the Executive Committee, (1) that the JOURNAL be limited to about eighty pages per issue for the first part of next year increasing the number as finances permit; (2) that members of the society who have not paid their dues for two years be dropped from membership and in order to be reinstated must pay back dues in full; and (3) that the JOURNAL not be sent to anyone more than one year in arrears, was adopted.

Dr. Herbert Dalmat was elected to membership.

Mr. Weiss appointed Mr. Sherman, Mr. Teale and Mr. Becker members of the Nominating Committee.

Mr. Comstock spoke on the Monarch Butterfly—its range, taxonomy and subspecies. An abstract is appended.

THE MONARCH BUTTERFLY

The Monarch butterfly is widely distributed in the Americas where it develops a number of subspecies, *plexippus* in the north, *megalippe* in the south, with *erippus* in southeastern Brazil and what is known as ab. *fumosus* in considerable numbers on Western Canada. In the Antilles *plexippus* from the north appears in normal form as far as Puerto Rico (apparently migrants) and *megalippe* comes in from the south through the Lesser Antilles. However, in Puerto Rico there is a distinct and apparently sedentary subspecies *portoricensis* recently described by Austin H. Clark and in the Virgin Islands there is the subspecies *leucogyne* Butler. Although *plexippus* is so extensively modified in the American continental and insular regions, it has spread extensively without modification throughout the Pacific Islands even to Australia. It has been recorded also from Iceland, the British Isles and Europe.

ANNETTE L. BACON, *Secretary*.

The
New York Entomological Society

Organized June 29, 1892—Incorporated June 7, 1893

Certificate of Incorporation expires June 7, 1943

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P. M., in the AMERICAN MUSEUM OF NATURAL HISTORY, 77th Street and Columbus Avenue.

Annual dues for Active Members, $3.00; including subscription to the Journal, $4.50.

Members of the Society will please remit their annual dues, payable in January, to the treasurer.

Honorary President, WILLIAM T. DAVIS

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of the

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SEPTEMBER, 1942

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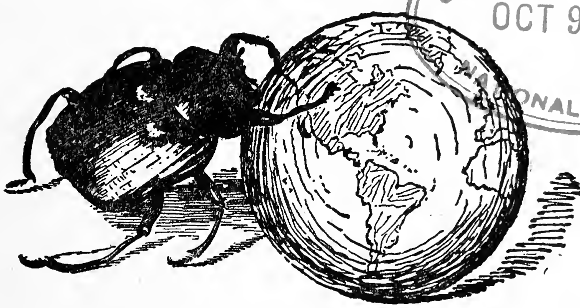
Devoted to Entomology in General



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JOURNAL

OF THE

New York Entomological Society

Vol. L — September, 1942 — No. 3

THE SARCOPHAGINÆ AND THEIR RELATIVES IN NEW YORK. II[1]

By Harold C. Hallock

Bureau of Entomology and Plant Quarantine, United States Department of Agriculture

Sarcophaga barbata Thomson

1869. Thomson, Eugenies Resa, p. 533.
1896. Pandelle (*S. falculata*), Rev. Ent., vol. 15, p. 185.
1913. Böttcher (*S. faculata* P.), Deutsche Ent. Zeitschr., p. 13 and 370 (syn.).
1916. Aldrich (*S. faculata* P.), *Sarcophaga* and Allies, p. 205.
1930. Aldrich (*S. barbata*), Proc. U. S. Nat. Mus., vol. 78, p. 27 (syn.).

The large hump on the caudal side of the anal forceps and the characteristic enlarged apex of the ædeagus (Figs. 137, 139) separate this species from *securifera*.

Length.—10 to 15 mm.

Records.—Ithaca; Nyack; *L. I.*: Babylon. June to September. Figures 137, 138, and 139.

[1] As the work reported in this paper was completed while the writer was at Cornell University, this is a contribution from the Department of Entomology, Cornell University, Ithaca, N. Y. The first two installments of this paper were published in the Journal of the New York Entomological Society, volume 48, pages 127–153 and 201–231 (1940).

Aldrich (1916)[2] and Davis (1919) recorded this species as parasitic on *Phyllophaga* sp. Illingworth (1922) found it breeding in carrion in Hawaii. Baranoff and Ježic (1928) reared it in Serbia from sores on sheep but only when *Wohlfahrtia magnifica* was present. Marchionatto and Blanchard (1933) found this species in Argentina as a parasite of the large grasshopper *Schistocerca paranensis.* This sarcophagid is generally reared as a scavenger, and the parasitic records in the literature are questionable. Knipling (1936) found that larvæ of *barbata* would develop in meat.

Sarcophaga bullata Parker

1916. Parker, Canad. Ent., vol. 48, p. 359.
1916. Aldrich, *Sarcophaga* and Allies, p. 233.

The distinguishing characters of *bullata,* which are most important in separating the species from closely related species, are as follows: The anal forceps taper to a sharp point and the discal segment of the ædeagus is broad and extremely blunt. The third abdominal segment has two median marginal bristles. The characters given in the key, together with the large reddish-yellow genital segment having a vertical slit guarded by strong bristles above, will separate the females from closely related species.

Length.—7 to 16 mm.

Records.—Ithaca; Nassau; Nyack; *S. I.*: Arrochar; *L. I.*: Cold Spring Harbor; Babylon; Islip; Fire Island Beach. May to August. Figures 140, 141, and 142.

This is a very common scavenger species in New York. Greene (1925) and Graenicher (1931) recorded the rearing of larvæ of this species from decaying meat and dead insects. Four years later Graenicher (1935) reared this species in Florida from human excrement. The writer during August 1935 left a pint jar with Asiatic garden bettle adults on the bottom of a beetle trap for a few days at Springfield, N. J. The funnel of the trap prevented the female *bullata* from reaching the dying beetles. The fly larviposited in the funnel and the first-instar maggots dropped about 6 inches to the beetles and completed their development on the beetles. The latter part of August 1935 a pint

[2] All literature cited in connection with the genus *Sarcophaga* will be found at the end of the last installment of this article.

jar which contained about 2 inches of decomposing dead beetles was tightly covered with two thicknesses of cheesecloth and left outdoors near Hainesville, N. J., for 5 hours in the middle of the day. The cheesecloth was removed and it was found that sarcophagid females had larviposited through the cheesecloth. Approximately two hundred puparia developed and the flies, which emerged, were determined as *bullata*. Knipling (1936) reared this species from meat. Knipling and Rainwater (1937) recorded five cases of myiasis in domestic animals in the southeastern part of the United States in which *bullata* larvæ were present.

Holotype and allotype.—Male and female in the Massachusetts Agricultural College.

Sarcophaga cingarus Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 288.

Although this species may be confused with *ventricosa*, it can be distinguished by the absence of anterior acrostichals, black legs, and more deeply golden pollinose parafrontals and parafacials. The anal forceps when viewed from behind are not separated from each other at the tip. Other genitalic differences are given in the illustrations.

Length.—7 to 9 mm.

Records.—Ithaca; Greene County; Oneonta; Tuxedo; *L. I.*: Babylon. June to August. Figure 143.

Data are not available about the life history.

Holotype and allotype.—Male and female No. 20569, United States National Museum.

Sarcophaga cistudinis Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 278.

The front is approximately as wide as one eye in both sexes. On the front of the discal portion of the ædeagus are a pair of characteristic lobes which are curved toward the apex of the segment. These characters easily separate this species from all other *Sarcophaga* occurring in this region.

Length.—8 to 10 mm.

Records.—The only record of this fly in New York was in Sep-

tember 1934, when Mr. A. Miller collected at Wading River, L. I., a small box turtle (3 inches long) with an opening in each shoulder. The turtle was kept at room temperature. Upon its death in December an examination disclosed that the openings led into internal pouches harboring 11 larvæ on one side and 4 on the other. These larvæ pupated early in January 1935 and the adult flies emerged about a month later. Aldrich (1916) recorded that the type was reared "from larva bred in sore on side of box turtle, Plainfield, N. J., hatched June 1912. W. DeW. Miller, col.," figure 144.

Holotype and allotype.—Male and female, in collection of Wm. T. Davis.

Sarcophaga coloradensis Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 139.

This species has been recorded from Colorado and New Bedford, Mass. It has been included in the key, as there is a possibility that it will be found in New York.

Holotype and allotype.—Male and female in Hough collection.

Sarcophaga cooleyi Parker

1914. Parker, Canad. Ent., vol. 46, p. 417.
1916. Aldrich, *Sarcophaga* and Allies, p. 225.

This large species is rather easy to separate from other members of the genus found in New York by the lack of marginal bristles on the third abdominal segment. The genitalic characters are also very distinctive.

Length.—10 to 14 mm.

Records.—Ithaca, May. Figure 145.

Parker (1914c) reports rearing the species in numbers from decaying fish. He also stated that the adults were common in privies and around garbage. Twinn (1934), in Saskatchewan, found the larvæ of this species in the ear of a man. Stewart (1934) gave a fuller report as follows: "Four maggots syringed from the ear of a man at Indian Head, Saskatchewan, and reared in the laboratory on raw meat emerged as flies of the species *Sarcophaga cooleyi* Park. (det. G. S. Walley). The maggots were removed before permanent injury resulted to the ear, but the ear

drum was noticeably thickened and partially perforated in a number of places."

Type.—Male in the Massachusetts Agricultural College.

Sarcophaga excisa Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 127.

This species has not been recorded in New York. As it occurs in Massachusetts and extensive collecting in New York will probably find the fly, it is included in this paper.

Information is not available on the biology of this species.

Holotype.—Male, No. 20514, United States National Museum.

Sarcophaga flavipalpis Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 256.

The dark-yellow palpi together with the keel-like caudal margin of the ædeagus make this species easily recognized. This fly has not been found in numbers in New York State, although several large collections from New York have been examined by the writer.

Length.—8 to 10 mm.

Records.—Ithaca; Rock City; Conquest. June to August. Figures 146, 147, and 148.

Aldrich (1916) recorded that the species was reared at Enola, Va., in 1915 from a myriapod (*Spirobolus* sp.).

Holotype and allotype.—Male and female, No. 20561, United States National Museum.

Sarcophaga fletcheri Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 96.

The majority of the specimens of *fletcheri*, that are to be found in collections, have been reared. The larvæ are aquatic and live in water in the cups of the pitcher plants (*Sarracenia* sp.) which grow in sphagnum swamps. Careful collecting in the immediate vicinity of pitcher plants, where it is breeding, during June, July, and August will secure many adult specimens. The fly was plentiful at McLean Bog during July 1936.

Length.—6½ to 11 mm.

Records.—Malloryville; McLean. July. Figures 149, 150, and 151.

Aldrich (1916) recorded this species breeding in pitcher plants. Dr. Fred Baker and the writer reared this fly from pitcher plants near Malloryville during July 1935 and 1936. As the larvæ are predaceous on living and dead insects and will attack one another, only a single sarcophagid can mature in each plant. The young first instars can live only in water from pitcher plants. The older larvæ (third instars and some nearly mature second instars) will complete their development in any water if there is sufficient food present.

Holotype and allotype.—Male and female, No. 20505, United States National Museum.

Sarcophaga hæmorrhoidalis (Fallen)

1816. Fallen, Vet. Akad. Handl., p. 236 (*Musca*).
1830. Wiedemann (*S. georgina* W.), Auss. Zweif., vol. 2, p. 363.
1913. Böttcher (*S. georgina* Wied.), Deutsch. Ent. Zeitschr., p. 10, 369.
1916. Aldrich, *Sarcophaga* and Allies, p. 189.
1927. Lundbeck, Dipt. Dan., pt. 7, p. 196.
1930. Aldrich (*S. georgina* W.), Proc. U. S. Nat. Mus., vol. 78, p. 4 (syn.).

The adult fly is distinguishable from all other *Sarcophaga* by the characteristic notch on the caudal margin of the straight anal forceps.

This species is cosmopolitan in its distribution, as it occurs on all the continents with the exception of Australia.

Length.—10 to 14 mm.

Records.—Albany; Buffalo; Ithaca; Lancaster; Potsdam; Tuxedo; *S. I.*: Watchogue; Wadsworth; *L. I.*: Cold Spring Harbor; Babylon; Sands Point. June to September. Figures 152, 153, and 154.

Parker (1914b) reported rearing the fly from human excrement. Aldrich (1916) gave an account of seven cases of human intestinal myiasis and stated that the larvæ of this species have the ability to develop almost or quite to full size within the alimentary tract of man. This has not been proved for any other

species. Haseman (1917), Keilin (1924), and Onorató (1922) gave further accounts of intestinal myiasis occurring in man. Moutia (1930) found it developing occasionally in sores or wounds on domestic animals. Hinds and Dew (1915) record the species as parasitic on the larvæ of the fall armyworm. Regnier (1931) gave an account of rearing the fly from adult *Schistocerca gregaria*. Webster (1907) records the parasite from *Caloptenus differentialis* in Wyoming. Although there are a few questionable published records of this species being reared as a parasite of insects, it seems best to limit the "parasitic habits" of the species to those cases of human myiasis. Knipling (1936) reared this fly from meat and excrement.

Type.—Presumably in the Academy of Sciences in Stockholm.

Sarcophaga houghi Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 170.

This parasitic sarcophagid is one of the rarer forms, and the adult male is easily recognized by the large, unusual hump on the caudal margin of the apex of the ædeagus. The female has not been seen.

Length.—8 to 9 mm.

Records.—Buffalo; Ithaca; New York City: *L. I.*: Babylon; Heckscher State Park. May to June. Figures 155, 156, and 157.

Glendenning (1914) records this species as a parasite of the larvæ of the satin moth in British Columbia. Knull (1932) reared the fly from pupæ of the fruit-tree leaf roller and pupæ of the elm spanworm in Pennsylvania under forest conditions.

Holotype.—Male, No. 20533, United States National Museum.

Sarcophaga hunteri Hough

1898. Hough, in paper by Hunter, Kans. Univ. Quar., vol. 7, p. 205–210.

1916. Aldrich, *Sarcophaga* and Allies, p. 102.

This species is close to *atlanis* but the yellow palpi and striking tuft of long hair on the anal forceps of *hunteri* distinguish the two species.

Length.—5 to 6 mm.

Records.—*S. I.*: Wadsworth; New Dorp; *L. I.*: Babylon. June and July. Figures 158, 159, and 160.

Aldrich (1916) lists 20 records of this species parasitizing grasshoppers (*Melanoplus differentialis* and *M. atlanis*) from widely distributed parts of the United States. Hunter (1898) stated that 12 per cent in 1897 and 20 per cent in 1898 of the grasshoppers were parasitized by *hunteri*, but it was later shown that his specimens were a mixture of several species. He also estimated that the dead grasshoppers on the ground were about equal to those moving around. Treherne and Buckell (1924) gave records of *hunteri* parasitizing grasshoppers in British Columbia.

Type.—In Hough collection.

Sarcophaga johnsoni Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 162.

This large sarcophagid has rarely been observed in the field in New York. The species has been taken only at points a short distance from the ocean. The more important characters of this species are the wide front, long, dense villosity on the discal half of the mid tibiæ, and the large black genitalia.

Length.—10 to 14 mm.

Records.—New York City (Pelham Park); Nyack; *L. I.*: Babylon; Oak Beach; Long Beach. June to September. Figures 161, 162, and 163.

Holotype and allotype.—Male and female, No. 20534, United States National Museum.

Sarcophaga montanensis Hallock

1938. Hallock, Proc. Ent. Soc. Wash., vol. 40, p. 98.

This species was described from one male specimen, received from Mr. D. G. Hall, which was collected July 4 at White Face Mountain, Adirondacks, N. Y., altitude 3,800 feet (J. M. Aldrich). Figure 164.

Holotype.—Male, Cat. No. 52085, United States National Museum.

Sarcophaga niagarana Parker

1918. Parker, JOUR. N. Y. ENT. SOC., vol. 26, p. 28.

This species is represented by a single specimen, the holotype, which is now in the collection of David G. Hall at Washington,

D. C. The characters given in the keys of this paper will separate this species from all other New York *Sarcophaga*.

Length.—10 mm.

Record.—Niagara Falls.

Holotype.—In collection of David G. Hall.

Sarcophaga nox Hall

1931. Hall, Ent. News, vol. 42, p. 217–219.

The characters of this rarely collected species are given in detail by Hall and will not be repeated here. The illustration and characters given in the key will distinguish this species.

Length.—10 to 11 mm.

Records.—*L. I.*: Babylon, June. The fly has been found in sandy areas along the Atlantic shore from Long Island, N. Y., to Florida. Figure 165.

Holotype and allotype.—Male and female, No. 43315, United States National Museum.

Sarcophaga parallela Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 123.

Aldrich (1916) indicated that this form is very closely related to *sima* and that it might even be a variety of *sima*. The chætotaxy and structural characters indicated in the key and the illustrations of genitalic structures clearly separate the two forms, and they appear more distinct than many other forms now indicated as distinct species.

Length.—7 to 9 mm.

Records.—Inwood; *L. I.*: West Hills. April to October. Figures 166, 167, and 168.

Leonard (1928) records a pupa in a dead *Helix thyroides*.

Holotype.—Male, No. 20512, United States National Museum.

Sarcophaga rapax Walker

1849. Walker, List of Diptera in Brit. Mus., vol. 4, p. 818.
1890. Townsend (*S. helicis*), Psyche, vol. 6, p. 220.
1895. Coquillett (*Helicobia helicis*), Proc. Acad. N. Sci. Phila., p. 317.
1916. Aldrich (*S. helicis* T.), *Sarcophaga* and Allies, p. 158.

1930. Aldrich (*S. rapax* W.), Proc. U. S. Nat. Mus., vol. 78, p. 15 (syn.).

Walker's species, *rapax,* is the most common species of Sarcophagidæ in New York State. Hall (1928) stated that it is the most common in the southern part of the United States but that it is not tropical in its distribution. It is the smallest sarcophagid found in New York and both sexes are very easily recognized by the characters given in the key.

Length.—3 to 8 mm.

Records.—Canajoharie; Rome; Oneonta; Troy; Hancock; Keen Valley; Buffalo; Syracuse; Ithaca; *L. I.*: Sea Cliff; Babylon. May to September. Figures 169, 170, and 171.

Aldrich (1916), Hayes (1917), Graenicher (1931), and Roberts (1934) have all pointed out that *rapax* will larviposit on dead insects or decaying meat and develop as a scavenger. Kelly (1914) determined that the species is a grasshopper parasite at times. Aldrich (1916) lists the following hosts for *rapax:* Adult *Corydalis cornuta,* adult *Cicada tibicen, Leucania unipuncta,* adult *Lachnosterna arcuata,* adult *Eleodes opaca,* and a myriapod (*Spirobolus* sp.). There may also be added the following parasitic records: Adult *Phyllophaga* sp. recorded by Davis (1919), larvæ of *Epiglaea apiata* by Beckwith and Driggers (1926–27), larvæ of *Diatraea saccharalis* by Plank (1929), larvæ of *Papaipema nebris* by Decker (1931), larvæ of *Macronoctua onusta* by Breakey (1931), adults of *Euetheola rugiceps* by Ingram and Bynum (1932), Mexican bean beetle by Friend and Turner (1931), and larvæ of *Anticarsia gemmatalis* by Hinds and Osterberger (1931). All indications lead to the conclusion that *rapax* is not an important parasite in the control of economic insects. Knipling (1936) found that larvæ of *rapax* would develop on meat. While investigating insects found in the upper air, Glick (1939) collected adult *rapax* at 20, 200, and 1,000 feet above the ground.

Sarcophaga reversa Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 135.

This species is characterized by a long projecting loop at the apex of the ædeagus which doubles back cephalad. There is a

large visible opening between the loop and the main portion of the ædeagus.

Length.—7 to 9 mm.

Records.—Ithaca; Greene County; *S. I.*: New Dorp; Fort Wadsworth. August to September. Figures 172, 173, and 174.

Holotype.—Male, No. 20519, United States National Museum.

Sarcophaga sarraceniæ Riley

1873. Riley, Trans. Acad. Sci. St. Louis, vol. 3, p. 238.
1916. Aldrich, *Sarcophaga* and Allies, p. 86.

A single specimen of this pitcher plant sarcophagid was taken July 1, 1936, near Treman Lake, Ithaca, N. Y., which is the only record for the State.

Length.—8 to 12 mm.

Record.—Ithaca. Figure 175.

Riley (1873) gave a description of the immature stages and adult which was accompanied by illustrations of the stages and notes on the feeding habits in the pitcher plant. Aldrich (1916) recorded additional rearings of *sarraceniæ* and separated the species from five closely related species which also breed in pitcher plants.

Holotype.—Male in United States National Museum.

Sarcophaga scoparia var. *nearctica* Parker

1916. Parker, Canad. Ent., vol. 48, p. 359.
1916. Aldrich (*S. scoparia* Pand.), *Sarcophaga* and Allies, p. 214.

Parker (1916a) pointed out that *nearctica* is extremely variable. The first segment of the genitalia tends to become brownish and there is some variation in the structure of the ædeagus. The true status of this species can be determined only by the study of a long series of reared material.

Length.—11 to 15 mm.

Records.—Tuxedo; Oneonta; Canandaigua; Keene; Hamburg; Cattaraugus; Ithaca; New York City; *S. I.*: Fort Wadsworth; *L. I.*: Cold Spring Harbor; Sea Cliff. May to September. Figures 176, 177, and 178.

Parker (1916a) recorded that this species larviposited on dung

and refuse. The writer found in 1935 that *nearctica* under cage condition would larviposit readily on fresh meat and the larvæ developed normally.

Type.—In the collection of the Massachusetts Agricultural College.

Sarcophaga securifera Vill.

1908. Villeneuve, Mitteilungen aus dem Zoolog. Mus. in Berlin, p. 123.

1913. Böttcher, Deutsch. Ent. Zeitschr., p. 15.

1916. Aldrich, *Sarcophaga* and Allies, p. 202.

The original description of this species was written by Villeneuve and published as a part of an article by Becker (1908) on the Diptera of the Canary Islands. Böttcher (1913) pointed out that part of Schiner's series of *dalmatina* were the same as *securifera.* This may account for the listing of *dalmatina* in the New York list (Leonard, 1928). The American specimens were probably misidentified, as it is doubtful if *dalmatina* occurs in North America.

Length.—9 to 14 mm.

Records.—Yonkers; Buffalo; Albany; *S. I.*: New Brighton; *L. I.*: Cold Spring Harbor; Flatbush; Brooklyn. June to September. Figures 179, 180, and 181.

This fly was reared by A. Miller from meat exposed at Brooklyn in early September 1934. The larvæ pupated during September but the adults did not emerge until May 1935. Greene (1925) and Smith (1933) also record this fly breeding in decaying liver and fresh meat. Baranoff and Ježic (1928) found *securifera* in Serbia breeding in sores upon sheep but only when *Wohlfahrtia magnifica* larvæ were present. Gee (1930) reported this species as a parasite of the larvæ of *Stilpnotia ochripes* M. in China.

Type.—In the collection of Dr. J. Villeneuve, Rambouillet, France.

Sarcophaga setigera Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 138.

The characters are similar to those of *excisa* but the two species can be separated by the structures mentioned in the keys.

Length.—9 mm.

Records.—*L. I.*: Richmond. June 16. This species is widely distributed but is never taken in numbers.

Sarcophaga setigera was reared by Branch (1920) as a parasite of the adult mantis *Stagmomantis carolina.* Branch recorded in her paper that the *setigera* larva wove a web around itself before pupating. This is the only known record of the web-spinning habit in the family Sarcophagidæ.

Holotype and allotype.—Male and female, No. 20522, United States National Museum.

Sarcophaga sima Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 91.

This sarcophagid belongs to Aldrich's group B and can be separated from the other members of the group only by genitalic characters. This species is not closely related to *S. parallela.*

Length.—8 to 10 mm.

Records.—Ithaca; Thacker Park; Conquest; Trenton Falls. May to August. Figure 182.

Swingle (1931) recorded the rearing of *sima* from a larva of *Curculio caryæ* H. in Alabama.

Holotype and allotype.—Male and female, No. 20502, United States National Museum.

Sarcophaga sinuata Meig.

1828. Meigen, Syst. Beschr., vol. 5, p. 22.
1912. Böttcher, Deutsch. Ent. Zeitschr., p. 708.
1916. Aldrich, *Sarcophaga* and Allies, p. 67.

This species is very easily recognized in both sexes by a patch of silky-yellow hair on the outer third of the front side of each middle femur.

Length.—5 to 9 mm.

Records.—Freeville; Rome; Troy; Buffalo; Cattaraugus; Ithaca; White Plains; Kiamesha; Mosholu; *S. I.*: Richmond; Fort Wadsworth. May to October. Figures 183, 184, and 185.

Aldrich (1916) reported *sinuata* as a parasite of *Melanoplus differentialis* in Colorado. Kelly (1914) recorded this species as a grasshopper parasite in Pennsylvania.

Type.—In the Meigen Collection in Paris.

Sarcophaga fulvipes var. *triplasia* V. d. W.

1896. Van der Wulp (*S. triplasia*), Biol. Centr.-Amer., Diptera, vol. 2, p. 283.
1917. Parker (*S. fulvipes* var. *dissidia*), Canad. Ent., vol. 49, p. 157.
1930. Aldrich (*S. fulvipes* var. *triplasia* V. d. W.), Proc. U. S. Nat. Mus., vol. 78, p. 35 (syn.).

This species is represented by one male and three females in the type series from Mexico. Aldrich (1930) studied the type in Europe and pointed out that Parker's *dissidia* had previously been described as *triplasia*.

Records.—Niagara Falls.

Sarcophaga uncata V. d. W.

1896. Van der Wulp, Biol. Cent.-Amer., Diptera, vol. 2, p. 277.
1896. Van der Wulp (*S. tridens*), Biol. Cent.-Amer., Diptera, vol. 2, p. 281.
1916. Aldrich (*S. marginata*), *Sarcophaga* and Allies, p. 136.
1930. Aldrich (*S. uncata* V. d. W.), Proc. U. S. Nat. Mus., vol. 78, p. 33 (syn.).

The antennæ reach three-fourths of the way to the vibrissæ. The fourth abdominal segment is entirely black. The fifth sternum of the male is V-shaped with delicate hairs along the inner margin as shown in figure 187. The distal portion of the ædeagus has a fringe-like expansion and at the apex is deeply cut by a notch (fig. 186).

Length.—8 to 9 mm.

Records.—Ithaca; Troy; *L. I.*: Babylon. May to September. Figures 186, 187, and 188.

Aldrich (1916) recorded that this species was reared from dead grasshoppers which had been placed in cages.

Sarcophaga utilis Aldrich

1915. Aldrich, Jour. Econ. Ent., vol. 8, p. 151.
1916. Aldrich, *Sarcophaga* and Allies, p. 275.

The group of short bristly hairs on the front and back side of the anal forceps near the tip is very characteristic of this species.

Length.—7 to 14 mm.

Records.—Ithaca; McLean; Cattaraugus; *L. I.*: Cold Spring Harbor. Figure 189.

Aldrich (1915, 1916) reported rearings of this fly from *Allorhina nitida* and *Geotrupes splendidus.* Davis (1919) recorded *utilis* reared from *Phyllophaga* sp. adults in Illinois. Knipling (1936) reared larvæ of *utilis* by placing them on meat.

Type.—Male in the United States National Museum.

Sarcophaga ventricosa V. d. W.

1896. Van der Wulp, Biol. Cent.-Amer., Diptera, vol. 2, p. 274.
1896. Van der Wulp (*S. tenuiventris*), Biol. Cent.-Amer., Diptera, vol. 2, p. 282.
1916. Aldrich (determined as *S. assidua* Walk.), *Sarcophaga* and Allies, p. 285.
1930. Aldrich (*S. ventricosa* V. d. W.), Proc. U. S. Nat. Mus., vol. 78, p. 18, 31, 34.

Sarcophaga ventricosa is easily distinguished from the other sacrophagids of New York by the partially red legs and the shape of the anal forceps, which turn back at the apex to form a barbed-like appearance. The points of the forceps, when viewed from behind, are decidedly divergent.

Length.—6 to 8 mm.

Records.—Lake Erie; Lancaster; Hamburg; Tuxedo; Milford Center; *S. I.*: Fort Wadsworth; *L. I.*: Babylon. June to October. Figures 190, 191, and 192.

Aldrich (1916) and Wilson (1932) recorded long series of this species reared from cow manure, horse manure, and straw. Luginbill (1928) records *ventricosa* as a parasite of the larvæ of the fall armyworm, *Laphygma frugiperda.* Knipling (1936) was able to rear *ventricosa* by placing larvæ either on excrement or meat.

Sarcophaga yorki Parker

1919. Parker, JOUR. N. Y. ENT. SOC., vol. 27, p. 265.

This species was described by Parker from two specimens which were collected at Niagara Falls, N. Y. This species has never been recorded since the original collection. The character of the apical end of the ædeagus, forming a semicircle when viewed

toward the tip, separates this species from other *Sarcophaga* recorded from New York.

Length.—11 mm.

Records.—Niagara Falls.

Holotype and paratype.—In the collection of David G. Hall.

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[3] As this paper is a continuation of "The Sarcophaginæ and Their Relatives in New York. II," JOUR. N. Y. ENT. SOC., vol. 48, p. 201–231, 1940, all literature citations in the 1940 paper and this paper are combined at the end of this paper.

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PLATE XV

Figure 137. Lateral view of external genitalia of *Sarcophaga barbata* Thomson.

Figure 138. Fifth sternum of *Sarcophaga barbata* Thomson.

Figure 139. Rear view of anal forceps of *Sarcophaga barbata* Thomson.

Figure 140. Lateral view of external genitalia of *Sarcophaga bullata* Parker.

Figure 141. Fifth sternum of *Sarcophaga bullata* Parker.

Figure 142. Rear view of anal forceps of *Sarcophaga bullata* Parker.

Figure 143. Lateral view of external genitalia of *Sarcophaga cingarus* Aldrich.

Figure 144. Lateral view of external genitalia of *Sarcophaga cistudinis* Aldrich.

Figure 145. Lateral view of external genitalia of *Sarcophaga cooleyi* Parker.

Figure 146. Lateral view of external genitalia of *Sarcophaga flavipalpis* Aldrich.

Figure 147. Fifth sternum of *Sarcophaga flavipalpis* Aldrich.

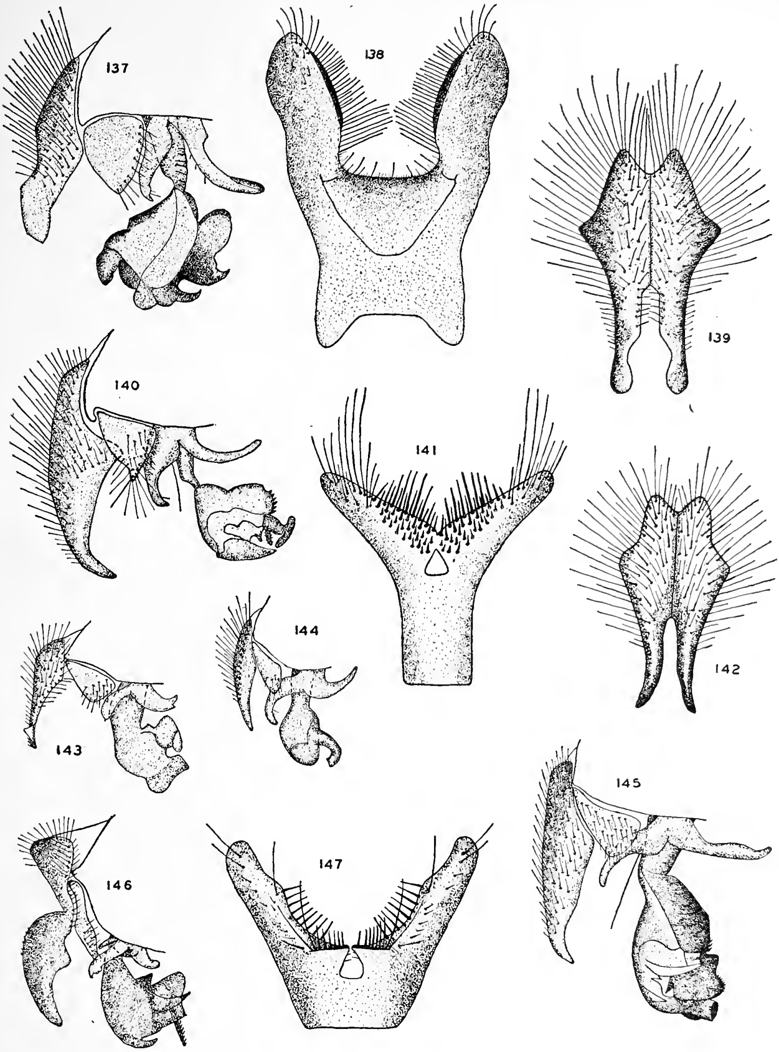
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PLATE XVI

Figure 148. Rear view of anal forceps of *Sarcophaga flavipalpis* Aldrich.
Figure 149. Lateral view of external genitalia of *Sarcophaga fletcheri* Aldrich.
Figure 150. Fifth sternum of *Sarcophaga fletcheri* Aldrich.
Figure 151. Rear view of anal forceps of *Sarcophaga fletcheri* Aldrich.
Figure 152. Lateral view of external genitalia of *Sarcophaga hæmorrhoidalis* Fallen.
Figure 153. Fifth sternum of *Sarcophaga hæmorrhoidalis* Fallen.
Figure 154. Rear view of anal forceps of *Sarcophaga hæmorrhoidalis* Fallen.
Figure 155. Lateral view of anal forceps of *Sarcophaga houghi* Aldrich.
Figure 156. Fifth sternum of *Sarcophaga houghi* Aldrich.
Figure 157. Rear view of anal forceps of *Sarcophaga houghi* Aldrich.
Figure 158. Lateral view of external genitalia of *Sarcophaga hunteri* Hough.
Figure 159. Fifth sternum of *Sarcophaga hunteri* Hough.
Figure 160. Rear view of anal forceps of *Sarcophaga hunteri* Hough.
Figure 161. Lateral view of external genitalia of *Sarcophaga johnsoni* Aldrich.

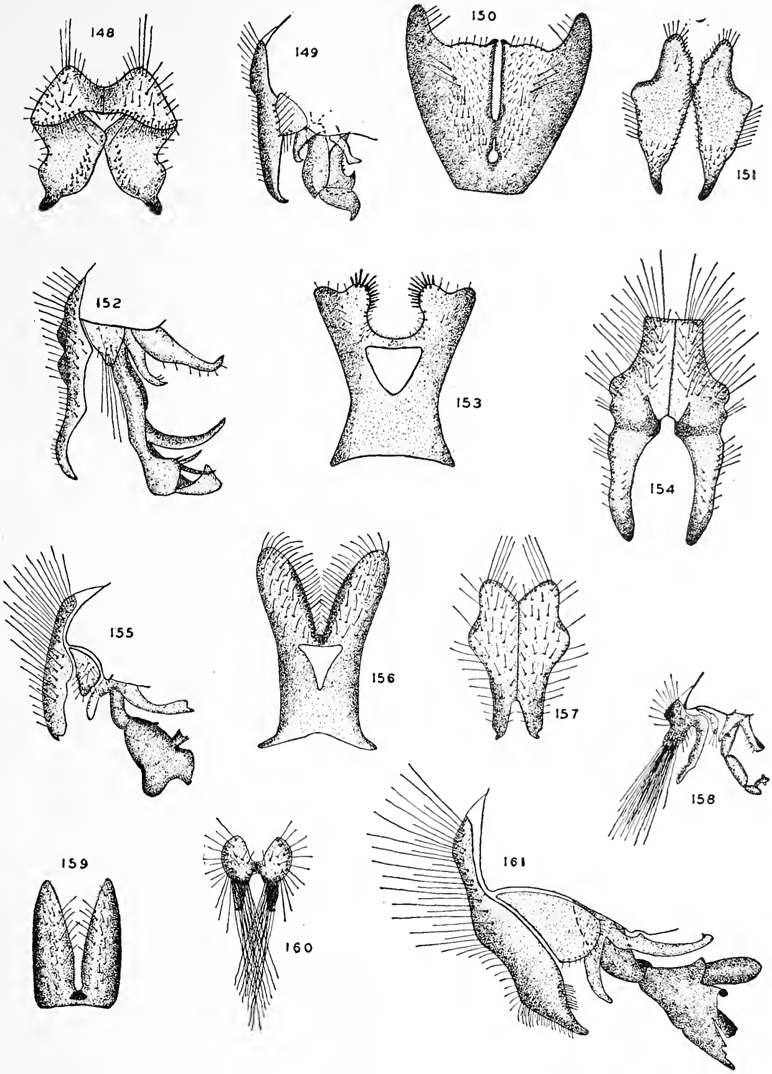
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PLATE XVII

Figure 162. Fifth sternum of *Sarcophaga johnsoni* Aldrich.
Figure 163. Rear view of anal forceps of *Sarcophaga johnsoni* Aldrich.
Figure 164. Lateral view of external genitalia of *Sarcophaga montanensis* Hallock.
Figure 165. Lateral view of external genitalia of *Sarcophaga nox* Hall.
Figure 166. Lateral view of external genitalia of *Sarcophaga parallela* Aldrich.
Figure 167. Fifth sternum of *Sarcophaga parallela* Aldrich.
Figure 168. Rear view of anal forceps of *Sarcophaga parallela* Aldrich.
Figure 169. Lateral view of external genitalia of *Sarcophaga rapax* Walker.
Figure 170. Fifth sternum of *Sarcophaga rapax* Walker.
Figure 171. Rear view of anal forceps of *Sarcophaga rapax* Walker.
Figure 172. Lateral view of external genitalia of *Sarcophaga reversa* Aldrich.
Figure 173. Fifth sternum of *Sarcophaga reversa* Aldrich.
Figure 174. Rear view of anal forceps of *Sarcophaga reversa* Aldrich.
Figure 175. Lateral view of external genitalia of *Sarcophaga sarraceniae* Riley.
Figure 176. Lateral view of external genitalia of *Sarcophaga scoparia* var. *nearctica* Parker.
Figure 177. Fifth sternum of *Sarcophaga scoparia* var. *nearctica* Parker.

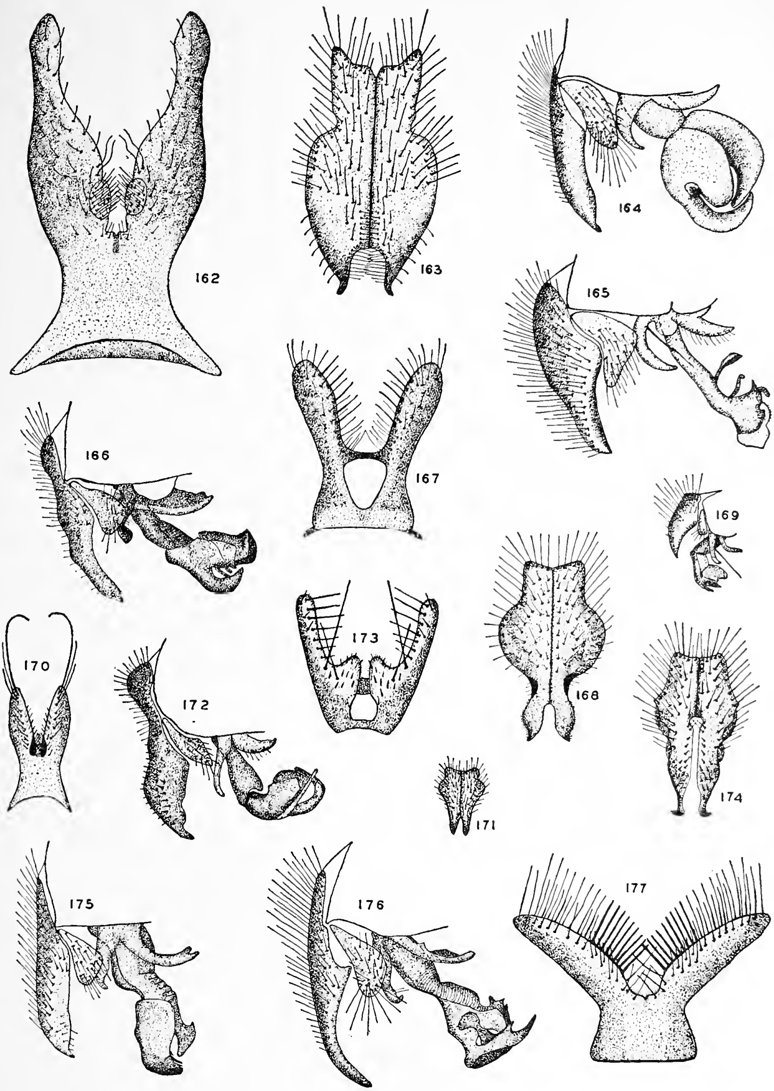
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PLATE XVIII

Figure 178. Rear view of anal forceps of *Sarcophaga scoparia* var. *nearctica* Parker.

Figure 179. Lateral view of external genitalia of *Sarcophaga securifera* Vill.

Figure 180. Fifth sternum of *Sarcophaga securifera* Vill.

Figure 181. Rear view of anal forceps of *Sarcophaga securifera* Vill.

Figure 182. Lateral view of external genitalia of *Sarcophaga sima* Aldrich.

Figure 183. Lateral view of external genitalia of *Sarcophaga sinuata* Meig.

Figure 184. Fifth sternum of *Sarcophaga sinuata* Meig.

Figure 185. Rear view of anal forceps of *Sarcophaga sinuata* Meig.

Figure 186. Lateral view of external genitalia of *Sarcophaga uncata* V. d. W.

Figure 187. Fifth sternum of *Sarcophaga uncata* V. d. W.

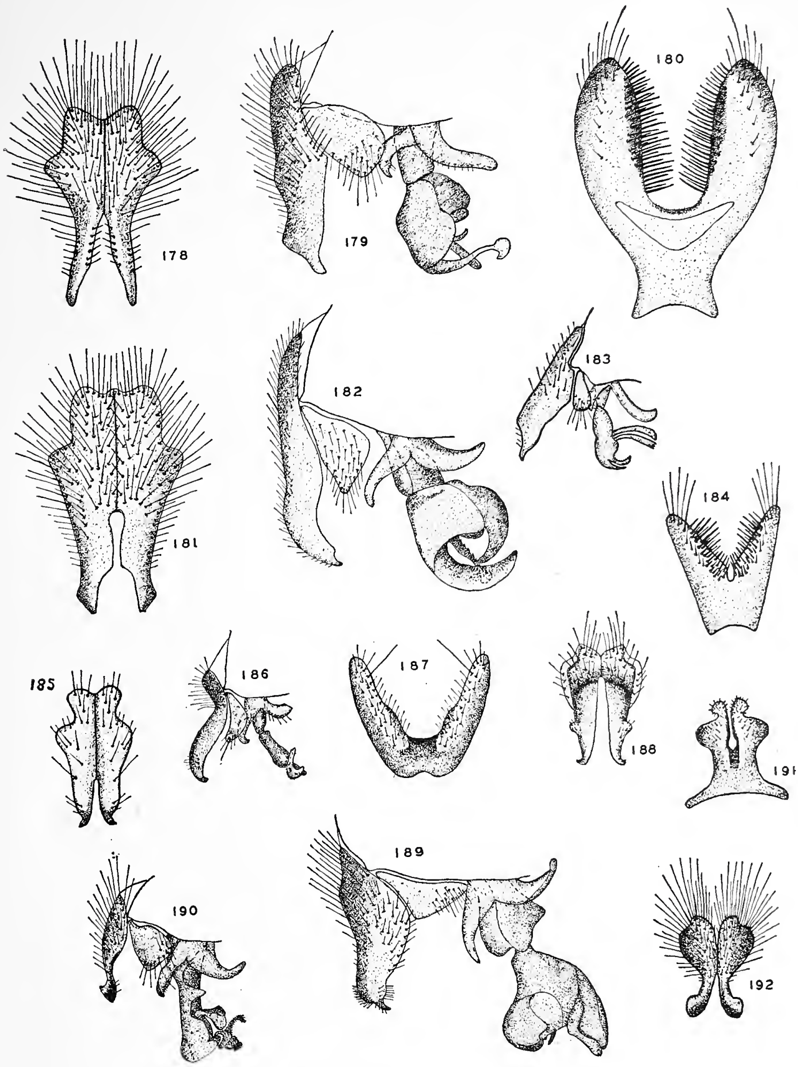
Figure 188. Rear view of anal forceps of *Sarcophaga uncata* V. d. W.

Figure 189. Lateral view of external genitalia of *Sarcophaga utilis* Aldrich.

Figure 190. Lateral view of external genitalia of *Sarcophaga ventricosa* V. d. W.

Figure 191. Fifth sternum of *Sarcophaga ventricosa* V. d. W.

Figure 192. Rear view of anal forceps of *Sarcophaga ventricosa* V. d. W.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BOOK NOTICE

General Entomology by S. W. Frost, McGraw-Hill Book Company, Inc., New York and London, 1942. 9 × 6 inches, x + 524 p., frontis., 406 illus. $4.00.

This book by Professor Frost, designed as a text for elementary college entomology, is a stimulating and interesting introduction to the subject. It is not an economic entomology and its 23 chapters are devoted to the systematic position of insects, their origin and distribution, their abundance, size and reproductive capacity, the orders of insects, metamorphosis, immature forms, morphology, color, sounds, behavior, social insects, food habits, associations of plants and insects, leaf miners, leaf rollers, gall insects, borers, subterranean species, aquatic species, case-makers, and insect inactivity. In addition there is an appendix containing keys to immature forms and to lepidopterous and coleopterous larvæ, synonymy of order names, classification schemes of orders from Linnæus to the present time, and a table showing the generic distribution of North American leaf miners. The extensive list of important references at the end of each chapter is exceedingly useful and the numerous illustrations are uniformly excellent.

It is apparent that this book was written by one who is thoroughly saturated with knowledge on all phases of entomology and who is deeply interested in insects as living organisms. Seldom are so many diverse subjects brought together within a single book and presented so enthusiastically, and in a manner to awaken interest among students. Within this book will be found the present-day answers to many questions that arise within the minds of thoughtful students, questions relative to the origin and distribution of insects, reproductive capacity, poisonous insects, extrication of young from eggs, analysis of fecula, insect coloration, insect color vision, photogenic organ of the firefly, insect sounds, commensalism, food habits, parasites, insect burrows, habits, sleep, cave fauna and others too numerous to mention. Although Professor Frost refers to his work as a textbook, which carries with it some implication of dryness, there is nothing dull about it and every page reflects his boundless and ardent interest in living insects.—H. B. W.

THE IDENTITY OF THE FLORIDA RACE OF LEPTOTES (LEPIDOPTERA, LYCÆNIDÆ)

BY HARRY K. CLENCH
CAMBRIDGE, MASS.

The *Leptotes* commonly found in Florida has for some time passed under the name of *L. theonus floridensis* Morrison.[1] An examination of a series of Florida specimens (including two cotypes of *floridensis*) in comparison with a large number of individuals from Cuba (type locality of *theonus*[2]) has shown that the specimens from the two localities are of the same form, and that as a consequence the name *floridensis* should be placed as a synonym of *theonus*. The only character that would seem to offer any basis for the retention of the name *floridensis* is that Cuban specimens frequently show a larger amount of white on the hind wing above in the male than is to be found in the Florida form, but as this is so variable in both Cuba and Florida (specimens from both places frequently being found with and without this white) there seems to be no reason for keeping the Florida specimens separate.

Theonus itself is but a race of the South American *cassius*[3] differing in the bluer hind wing above in the male, and the larger anal spots below on this wing in both sexes. The maculation is also heavier, especially on the hind wing.

Specimens have been examined from the following localities:

Leptotes cassius cassius Cramer.

Brasil: Rio de Janeiro; Canto Gallo; Para; Blumenau. Paraguay: Buena Vista. Argentina: Cordoba. "Colombia." "Amazon."

[1] 1873, Bull. Buffalo Soc. Nat. Sci., 1, p. 187 (Notes on North American Lepidoptera).

[2] Lucas, 1857, Lépidoptères *in* Ramon de la Sagra, Histoire physique, politique et naturelle de l'ile de Cuba. Animaux Articulés. Paris. [Vol. VII.] p. 611, pl. 16, f. 8, 8a, 8b. [This reference was not available to me, and was quoted from M. Bates, 1935, Bull. Mus. Comp. Zool., 78, pp. 246 and 198 (The Butterflies of Cuba).]

[3] Cramer, 1779, Papillons Exotiques, 1, p. 36, pl. 23, figs. c, d.

Leptotes cassius theonus Lucas.

Florida: Orlando; Sanibel Island; Miami; Key Largo; Royal Palm State Park; Upper Matecumbe Key; Soldier's Key; Key West (cotypes of *floridensis*). Bahamas: N. Bimini Id.; New Providence Id.; Cat Id.; Southern Eleuthera Id.; Gt. Inagua Id.; Stranger's Cay (Little Abaco Id.). Cuba: Soledad, Cienfuegos; Viñales; Rangel; Habana; Sierra Maestra (1000 ft.). Jamaica: St. Ann's Bay; Baron Hill, Jackson Town. Hispaniola: Ennery (1000 ft.); Port-au-Prince; La Selle Mts. (6000 ft.) (all Haiti); Beata Id. (Santo Domingo). Mexico: Acapulco. Honduras: Subirano Yoro; Bonacca Id. and Roatan Id. (both in the Bay Ids.); Minas de Oro (4000 ft.).

FURTHER ELECTRON MICROSCOPE STUDIES ON ARTHROPOD TRACHEÆ[1]

BY A. GLENN RICHARDS, JR.,[2] AND THOMAS F. ANDERSON[3]

In an earlier issue of this JOURNAL we have presented electron micrographs of tracheæ and tracheoles of the honey bee, the house mosquito and the American cockroach. Subsequently we have examined similarly prepared material from the larva of an unidentified scarabæid beetle and from adults of a millipede (*Fontaria* sp.), a centipede (*Scolopendra* sp.) and the common dog tick (*Dermacentor variabilis*). Since the pictures are similar to ones previously published, no illustrations are given in this note.

The centipede preparations showed only the expected tænidia and need not be described further.

In the tick a trachea (tracheole) approximately 0.7 μ in diameter shows supporting tænidial rings varying from 0.03 μ to 0.10 μ in width. The intertænidial membrane is not more than 0.02 μ thick and may be somewhat thinner than this.

In the millipede numerous tracheæ (tracheoles) varying from 1 μ to 3 μ in diameter were examined. All showed tænidia, ring-forms being commoner than helices. The tænidia vary in width from 0.05 μ to 0.10 μ, the size being correlated with the size of the trachea. The intertænidial membrane is not more than 0.02 μ thick.

In the beetle larva approximately 25 tracheæ (tracheoles) ranging in diameter from 0.3 μ to 0.7 μ (most of these were 0.3–0.5 μ in diameter) were examined. All of these showed supporting helical tænidia approximately 0.04 μ broad. The intertænidial

[1] Thanks are due to the Radio Corporation of America and to Dr. V. K. Zworykin for the use of an electron microscope in the RCA Research Laboratories, and to the National Research Council's Committee on Biological Applications of the Electron Microscope through which arrangements for this work were made.

[2] Zoological Laboratory, University of Pennsylvania, Philadelphia, Pennsylvania.

[3] RCA Fellow of the National Research Council, RCA Laboratories, Camden, New Jersey.

membrane is considerably thinner than the tænidia but cannot be estimated accurately from these micrographs.

It has been said that tracheæ differ from tracheoles by the presence of supporting thickenings called tænidia (see Richards and Anderson, 1942). There are several examples in which supporting tænidia have been reported absent, namely the Onychophora (*Peripatus* spp.), the smaller tubes of millipedes, and the so-called tracheoles of insects, this last being the classical example. Fresh material of Onychophora was not available for study but Dakin (1920) has already reported that with fresh material and favorable lighting tænidia can be discerned with the light microscope. Herein we report the presence of tænidia in the small tracheæ of millipedes although these are not discernible with the light microscope. We have already reported and figured (*loc. cit.*) tænidia in adult honey bee tracheoles (diameter 0.2 μ) and now report the same for tracheoles of a beetle larva (diameter 0.3–0.7 μ) and tracheoles of the mosquito pupa (diameter 0.5 μ). It seems probable, therefore, that the respiratory tubes of arthropods always possess supporting tænidia although in the case of minute tubules these thickenings are below the resolving powers of the light microscope. A distinction betwen tracheæ and tracheoles thus becomes questionable and of doubtful value.

There are two factors that would seem important in the construction of respiratory tubes, namely adequate support and adequate thinness to facilitate gaseous diffusion. It does not seem feasible to compute the amount of support given by these helical and circular thickenings but obviously tænidia do serve a supporting function. And the strength of the ribbed tube must be intermediate between that of a simple tube with the thickness of intertænidial membranes and a tube with the thickness of tænidia. In a teleological sense tracheal structure may be viewed as a compromise between the necessity of support and the desirability of a thin membrane.[4]

[4] It is commonly assumed that tracheæ are impermeable, and that the tracheoles are the loci of gaseous diffusion. This is not entirely true. Edwards (1940) has shown that tracheæ (as well as tracheoles) are permeable to fluids under certain conditions and so must be permeable to gases. We have shown that the intertænidial membrane of moderate-sized and even of some large-sized tracheæ is only 0.01–0.02 μ thick and that this is not

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SNODGRASS, R. E. 1938. Evolution of the Annelida, Onychophora and Arthropoda. Smithsonian Miscl. Coll., 97(6): 1–59.

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greatly different from the thickness of the walls of tracheæ (tracheoles) that are only 0.2–1.0 μ in diameter. Of course, diffusion is also conditioned by the cells surrounding these tubes and by chemical differences between various tubes (if such exist), but there seems to be no reason for assuming that the tracheæ have no significant part in the diffusion of gases to their immediate surroundings.

A NEW GENUS AND A NEW SPECIES OF OTITIDÆ FROM NORTH AMERICA (DIPTERA)

BY SAMUEL C. HARRIOT

I wish to thank Dr. Edward S. Ross for the privilege of examining specimens in the collection of the California Academy of Sciences.

Curranops, new genus

Differs from *Tetanops* Fallén in that, although the propleura and sternopleura are haired, the propleural bristle is absent, and there are no strongly differentiated sternopleural bristles. *Tetanops* has one or two sternopleurals. The cheeks are less than half the eye-height and the parafacials are much narrower than in *Tetanops*. Genotype:—*Tetanops apicalis* Cole (1921, Proc. Calif. Acad. Sci., vol. XI, p. 328).

The presence of dorsal setulæ on the apex of the first vein, the unbroken costa, the absence of a strong propleural bristle, the normal subcostal cell, and the well developed antennal grooves place this genus near *Myrmecomya* Desvoidy. *Myrmecomya,* however, has a longer third antennal segment, one strong sternopleural bristle, and narrower wings.

Originally described from Corvallis, Oregon. The writer has seen specimens of *apicalis* from Mt. Rainier National Park, Washington and Carmel, California.

Tetanops Fallén

This genus contains six species described from North America and five from the Old World. The North American species can be separated as follows.

TABLE OF SPECIES

1. Front wrinkled or with distinct punctiform markings 2
   Front not wrinkled, without punctiform markings .... *magdalenæ* Cresson
2. Front punctate; thorax black, densely cinereous pollinose, with black punctiform markings 3
   Front wrinkled; thorax shining black not cinereous pollinose. *myopæformis* Roeder
3. Front completely punctate, without a median red stripe 4
   Front with a median red stripe, only the sides punctate 5
4. Front, except for the pits, and facial carina cinereous pollinose; abdomen cinereous without black punctiform markings. Wings without distinct costal spots .... *integra* Loew

Lower margin of front and facial carina shining; abdomen cinereous with black punctiform markings. Wings with more or less distinct costal markings .... *cazieri* n. sp.

5. Front with four blackish stripes; face with four black spots. *vittifrons* Wulp

Front without distinct black stripes; only two facial spots 6

6. Wings with distinct costal spots; legs reddish, femora sometimes with a blackish band in the middle .... *rufifrons* Wulp

Wings without distinct costal spots; femora blackish, front and hind tibiæ brownish .... *luridipennis* Loew

Tetanops cazieri, new species

This species differs from *integra* Loew in having a shining facial carina, the abdomen has black punctiform markings, and the wings have more or less distinct costal markings. Length, about 8 mm.

FEMALE.—Head reddish yellow, slightly broader than high, the eyes not higher than the cheeks; front pitted, grayish pollinose except for the pits, the upper half and margins bordering the eyes blackish, the lower half of the front shining. Occiput grayish pollinose with blackish punctiform markings on the upper half. Cheeks shining, pollinose posteriorly, with a vertical brown spot extending from beneath the eyes more than half way to the oral margin. Face mostly shining, outer margins bordering the eyes pitted, grayish pollinose except for the blackish pits; the lower half of the antennal grooves black. Antennæ blackish, thinly pollinose; arista somewhat reddish basally. Proboscis blackish; palpi reddish yellow, black haired.

Mesonotum black in ground color, somewhat shining, covered with a cinereous pollen interrupted by numerous punctiform markings. Scutellum black, thinly grayish pollinose. Pleurites black in ground color, ashy pollinose, only the mesopleura and sternopleura with black punctiform markings. Two strenopleural bristles present.

Coxæ and femora black, base and apices of femora reddish yellow; tibiæ brownish; tarsi reddish yellow, apical two or three tarsal segments often blackish.

Wings grayish hyaline, veins brownish, with more or less distinct brownish markings along the costa; at the base and apex of the costal cell, apex of the stigma, above the origin of the submarginal cell, base of the submarginal cell, and base of the first basal cell. Squammæ white, halteres yellowish.

Abdomen black covered with grayish pollen interrupted by numerous punctiform markings. Ovipositor shining black.

Types.—Holotype, female, Cedarville, Modoc Co., California, May 30, 1939 (P. C. Ting, M. A. Cazier, J. A. Downes, T. H. G. Aitken), in the collection of the American Museum of Natural History. Paratype, female, Eagle Lake, Modoc Co., California, July 8, 1934 (J. T. Howell), in the collection of the California Academy of Sciences.

RECORDS AND DESCRIPTIONS OF NEOTROPICAL CRANE-FLIES (TIPULIDÆ, DIPTERA), XV

BY CHARLES P. ALEXANDER
AMHERST, MASSACHUSETTS

The preceding instalment under this general title was published in June, 1942 (JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, 50: 135–146). The new species considered at this time are all from western and southern Ecuador (Provinces of Manabi and El Oro) where they were collected by Mr. David B. Laddey, to whom I express my deepest thanks for this appreciated co-operation in making known this rich fauna. The types of the novelties are preserved in my collection of Tipulidæ.

Genus *Limonia* Meigen

Limonia (Rhipidia) dotalis new species.

General coloration of mesonotum buffy yellow, the præscutum with a median brown stripe; antennæ (male) with eleven bipectinate flagellar segments; dorsal thoracic pleurites blackened; legs obscure yellow, the terminal tarsal segments darkened; wings grayish subhyaline, patterned with brown and cream-colored areas; male hypopygium with the rostral prolongation of the ventral dististyle long and slender, with a low pale flange along its outer margin; two short rostral spines near base of prolongation; a strong powerful seta on prolongation just basad of the rostral spines.

MALE.—Length about 5–6 mm.; wing 5.5–7.2 mm.; antenna about 2.5–3 mm.

Rostrum and palpi black. Antennæ (male) relatively long, with eleven bipectinate segments, all flagellar segments excepting the last bearing conspicuous branches; branches of first segment a trifle shorter than the segment itself; succeeding segments with branches that are longer than the segments, the longest, at about midlength of organ, about one-half longer than the entire segment; branches of penultimate segment slightly unequal, the longest about equal to the segment; terminal segment about one-third longer than the penultimate; antennæ dark brown, including scape, pedicel, all branches, and the stems of the more proximal segments, the intermediate and outer segments with the stems whitened; terminal segment conspicuously pale, only the tip darkened. Head dark brownish gray; eyes of male broadly holoptic, obliterating the anterior vertex.

Pronotum blackened dorsally. Mesonotal præscutum obscure buffy yellow,

with a conspicuous brown median stripe, the lateral stripes lacking; scutum yellow, each lobe with a restricted brown area; scutellum pale yellow; mediotergite dark brown, paler laterally. Pleura chiefly blackened, more intensely so dorsally, the upper edge of the darkened area clear-cut, passing across the base of halteres; ventral pleurites paler. Halteres with stem yellow, knob infuscated. Legs with coxæ and trochanters dusky; femora obscure yellow, their tips weakly darkened; tibiæ and tarsi obscure brownish yellow, the terminal tarsal segments darkened; posterior tarsi not differently colored from others. Wings with ground color grayish subhyaline, variegated by darker brown and cream-colored markings; the darker areas include a costal series of five, the last at stigma, the third at origin of *Rs*, the areas more extensive than the creamy interspaces; cord and outer end of cell *1st* M_2 narrowly seamed with brown; remainder of ground color variegated by cream-colored areas, especially before and beyond stigma, behind the costal interspaces in cell *R*, a marginal mark in cell *1st A*, and the axillary region of both anal cells; wing-tip more or less distinctly cream-colored; veins brown, yellow in the costal interspaces. Venation: Sc_1 ending about opposite three-fifths the length of *Rs*, Sc_2 at its tip; cell *1st* M_2 shorter than vein M_3 beyond it; *m–cu* at or before the fork of *M*, in cases to about one-fourth its own length.

Abdominal tergites brownish yellow medially, darkened laterally and on caudal borders; ground color of basal sternites more obscure yellow, patterned like the tergites; outer segments and hypopygium more uniformly darkened. Male hypopygium with the tergite small, transverse. Basistyle with the ventromesal lobe stout basally, narrowed on caudal angle into a lobe that bears a single powerful seta. Dorsal dististyle a nearly straight rod, the tip acute. Ventral dististyle relatively small, about as long as the dorsal style; rostral prolongation long and slender, pale yellow, its outer margin produced into a low pale flange; the two unusually short spines placed close together near base of prolongation; immediately basad of rostral spines with a very long, powerful bristle. Gonapophysis with mesal-apical lobe stout at apex with the lateral angle further produced into a small blackened point.

Holotype, ♂, Las Pinas, Morro Morro, El Oro, altitude 1,500 meters, July 14, 1941 (Laddey). Paratypes, 2 ♂♂, Palmar, Manabi, altitude 200 meters, May 12–20, 1941 (Laddey).

The nearest ally of the present fly seems unquestionably to be *Limonia* (*Rhipidia*) *bruchiana* (Alexander), widely distributed in South America. This latter fly likewise has eleven branched flagellar segments, but with the branches longer than in the present species. It further differs in the coloration of the tarsi and in the details of structure of the male hypopygium, notably of the rostral prolongation of the basistyle, ventro-mesal lobe of basistyle, and the lobe of gonapophysis.

Genus *Polymera* Wiedemann

Polymera (Polymera) minutior new species.

Size small (wing, male, less than 4 mm.); general coloration of head and thorax uniformly dark brown; antennæ (male) more than one-half longer than body, black throughout; flagellar segments weakly binodose; legs black, the tarsi paling to dirty white; tibial spurs black, short and fimbriate; wings with a strong brownish gray tinge, unpatterned; *Sc* ending beyond the fork of *Rs*; R_{2+3+4} short, only about one-third R_{1+2}, the latter nearly as long as *Rs*; cell M_1 present; abdomen, including hypopygium, black.

MALE.—Length about 3 mm.; wing 3.6 mm.; antenna about 4.8 mm. Rostrum brown; palpi black. Antennæ (male) relatively long, more than one-half longer than body; antennæ black throughout; flagellar segments binodose, the swellings becoming even fainter on outer segments. Head dark brown.

Pronotum and mesonotum uniformly dark brown, the posterior sclerites a very little brighter than the præscutum. Pleura brown. Halteres brownish black, the extreme base of stem obscure yellow. Legs with coxæ and trochanters brown; remainder of legs black, the tarsi passing into dirty brownish white; tibial spurs black, short and fimbriate. Wings with a strong brownish gray tinge, unpatterned; veins brown. Venation: *Sc* relatively long, Sc_1 ending beyond fork of *Rs*, Sc_2 at its tip; R_{2+3+4} short, a little more than one-half R_{2+3} and only about one-third R_{1+2}, the latter only a little shorter than *Rs*; cell M_1 present; cell M_3 deep, about as long as its petiole; *m–cu* just beyond fork of *M*.

Abdomen, including hypopygium, black.

Holotype, ♂, Las Pinas, Morro Morro, El Oro, altitude 1,500 meters, July 20, 1941 (Laddey).

Polymera (*Polymera*) *minutior* is the smallest member of the typical subgenus *Polymera* so far described. It is closest to species such as *P.* (*P.*) *chiriquiensis* Alexander, of northern Panama, differing conspicuously in the size and in the coloration of the body, legs and wings.

Genus *Elephantomyia* Osten Sacken

Elephantomyia tigriventris new species.

General coloration of thorax light brown, the præscutum with a broad, conspicuous, dark brown, median stripe; a blackened girdle on thoracic pleura; halteres yellow; femora and tibiæ brown, the tips weakly darkened; wings subhyaline, stigma brown; Sc_1 ending about opposite five-sixths the length of *Rs*; *m-cu* at near one-third to one-fourth the length of cell; abdominal segments conspicuously banded black and yellow, the apices of the segments

broadly of the latter color to produce a tigrine appearance; male hypopygium with the outer dististyle terminating in a curved spine with numerous spinulæ grouped around the tip, including one major, more basal spine.

MALE.—Length, excluding rostrum, about 6 mm.; wing 5.3 mm.; rostrum about 5 mm.

Rostrum elongate, a little shorter than the body, light brown. Antennæ black throughout; flagellar segments elongate-cylindrical, with very long conspicuous verticils. Head dark brown; anterior vertex reduced to a narrow strip.

Mesonotal præscutum light brown, with a very broad and conspicuous dark brown median stripe; scutum pale brown; scutellum and mediotergite dark brown, the pleurotergite somewhat paler. Pleura chiefly light brown, with a conspicuous black area on mesepisternum forming a more or less distinct girdle. Halteres yellow. Legs with the coxæ pale, the middle pair darker; trochanters yellow; femora and tibiæ brown, their tips weakly darkened; tarsi somewhat paler; tibial spurs lacking. Wings subhyaline, the base a little more yellowish; stigma long-oval, brown; veins brown, brighter in the basal portions. Venation: Sc relatively long, Sc_1 ending about opposite five-sixths the length of Rs, Sc_2 at its tip; branches of Rs generally parallel to one another, only slightly divergent at tips; cell *1st* M_2 relatively short and broad, about equal in length to vein M_3 beyond it; *m-cu* at near one-third to one-fourth the length of cell; cell *2nd A* of moderate width.

Abdomen brownish black, conspicuously banded with yellow, the latter including about the distal third or fourth of each segment; eighth segment and hypopygium uniformly darkened. Male hypopygium with the outer dististyle terminating in a curved spine, with abundant smaller appressed spines and spinulæ back from this tip, the most basal of the series a powerful straight spine that is stronger than the apex itself. Inner dististyle broad basally, the distal third narrowed. Interbases appearing as broadly flattened blades, their tips narrowed. Ædeagus relatively short and simple, the tip only gently curved, not spiraliform as in many species of the genus.

Holotype, ♂, Palmar, Manabi, altitude 200 meters, May 12, 1941 (Laddey).

Elephantomyia tigriventris is very distinct from all other species of the genus so far made known. The peculiar structure of the male hypopygium indicates an isolated type. Because of the lack of tibial spurs, I hesitate to assign the species to any particular subgenus so far recorded from the New World.

Genus *Teucholabis* Osten Sacken

Teucholabis (Teucholabis) strumosa new species.

General coloration of mesonotum blackened, including a median shield on præscutum; pleura with a broad black dorsal stripe; halteres dull black;

legs with femora yellowish brown, the tips blackened; tibiæ dark brown, tarsi black; wings relatively narrow, strongly darkened, especially along the cord, with extensive paler areas before and beyond the cord; cell *1st* M_2 long and narrow, gently widened distally; male hypopygium with apical spine small and slender, nearly straight. terminating in a blackened apical point; inner dististyle bispinous, on outer margin with a strong tubercle bearing about five long setæ.

MALE.—Length about 5.5 mm.; wing 5.5 mm.

Rostrum relatively short, black throughout; palpi black. Antennæ black; flagellar segments oval, the more basal segments strongly constricted into very short apical necks; verticils exceeding the segments in length. Head brownish black, the central portion of vertex even darker.

Pronotum obscure yellow, slightly darkened laterally. Mesonotal præscutum with disk blackened, obliterating the posterior interspaces, the reddish yellow ground restricted to the broad humeral and lateral portions; scutal lobes extensively blackened, the median area obscure brownish yellow; scutellum black, the posterior border a little paler; mediotergite reddish yellow, more darkened on central portion. Pleura obscure yellow, with a conspicuous black dorso-longitudinal stripe extending from the cervical region across the dorsal pleurites to the abdomen, involving the dorsal pteropleurite and most of the pleurotergite. Halteres dull black. Legs with the coxæ yellow, the fore pair more darkened; trochanters brownish yellow; femora obscure yellowish brown, the tips broadly black, the amount subequal on all legs; tibiæ dark brown, their tips blackened; tarsi black. Wings relatively narrow; ground color strongly infuscated to blackened, still darker from the stigma backward across the anterior cord; poorly delimited pale areas before and beyond the cord; prearcular and costal fields similarly brightened; veins dark brown. Venation: Sc relatively long, Sc_1 ending about opposite midlength of the long, very gently arcuated Rs, Sc_2 a short distance from its tip; R_{1+2} and R_2 subequal; cell *1st* M_2 long and narrow, gently widened distally, a little shorter than vein M_3 beyond it; m–cu about one-third its length beyond the fork of M.

Abdominal tergites black; sternites weakly bicolored, the incisures darkened; hypopygium with the ninth segment obscure yellow; styli blackened. Sternal pocket of sixth segment relatively sparse, the setæ of either side widely separated. Male hypopygium with the apical spine of basistyle small and very slender, nearly straight, gradually narrowed to the acute blackened apical point; surface of spine with scattered setæ; mesal edge of basistyle with a conspicuous blackened flange that is provided with a few setæ, some of large size. Outer dististyle broken. Inner dististyle of distinctive shape, the usual two points appearing as very large and powerful spines separated by a broad U-shaped notch; outer margin of style with a strong blackened tubercle provided with about five very long and strong setæ.

Holotype, ♂, Palmar, Manabi, altitude 200 meters, May 20, 1941 (Laddey).

Teucholabis (*Teucholabis*) *strumosa* is very different from the other numerous regional species of the genus. It is apparently closest to *T.* (*T.*) *anthracina* Alexander, but the resemblance is not particularly close.

Teucholabis (Teucholabis) rhabdophora new species.

Size small (wing, male, 4.5 mm. or less); general coloration of mesonotum reddish brown; pleura obscure yellow, variegated with brownish black; halteres dusky, the tips of knobs a little brightened; femora obscure yellow, their tips blackened; wings with a conspicuous brown tinge, the oval stigma darker brown; male hypopygium with the inner dististyle profoundly bifid, the outer arm a very long slender rod; ædeagus flattened, each lateral angle produced into arms that turn mesad and touch at the midline.

MALE.—Length about 4.5–5 mm.; wing 4–4.5 mm.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval, with conspicuous verticils. Head dark brownish gray.

Pronotum yellow above, darkened laterally. Pretergites yellow. Mesonotal præscutum almost uniform reddish brown, the humeral and lateral portions yellow; scutum almost uniform reddish brown; scutellum obscure yellow, parascutella darker; postnotum reddish brown, the posterior portion darker. Pleura obscure yellow, variegated with brownish black, including major areas on anepisternum, dorsal pteropleurite and pleurotergite, and again on the ventral sternopleurite, the latter area further involving the fore coxæ; pleura, coxæ and trochanters with long conspicuous black setæ. Halteres dusky, the apices of knobs a little brightened. Legs with fore coxæ darkened, remaining coxæ and trochanters yellow; femora obscure yellow, the tips blackened, the amount subequal on all legs; tibiæ yellowish brown; tarsi black. Wings with a faint but conspicuous brown tinge, the oval stigma darker brown; veins brown. Costal fringe (male) relatively long and dense. Venation: Sc_1 ending about opposite midlength of *Rs*, Sc_2 a short distance from its tip; branches of *Rs* divergent at outer ends, R_5 decurved to wing-tip; *m–cu* about one-third its length beyond fork of *M*.

Abdomen dark brown, including the hypopygium, the eighth and ninth segments more yellowish. Sternal pockets (male) very poorly developed. Male hypopygium with rod of basistyle subapical in position, narrowed to an acute blackened spine, the surface of rod with numerous spinulæ; mesal flange of basistyle conspicuous, provided with conspicuous teeth. Outer dististyle subequal in size to the spine of basistyle, stout, straight and simple, provided with long coarse setæ. Inner dististyle with its outer arm a very long slender rod that terminates in a spearlike head tipped with an acute blackened spine, the outer margin of arm with four or five scattered setæ; inner arm a flattened cultriform blade, the acute tip decurved. Ædeagus broadly flattened, at apex with either outer angle produced caudad and mesad into a long arm that touches its mate of opposite side, enclosing a broadly oval notch.

Holotype, ♂, Palmar, Manabi, altitude 200 meters, May 21, 1941 (Laddey). Paratototype, ♂, with type; paratype, ♂, Playones, Palmar, altitude 150 meters, May 15, 1941 (Laddey).

Superficially, *Teucholabis* (*Teucholabis*) *rhabdophora* resembles species such as *T.* (*T.*) *jocosa* Alexander but is entirely different from all described species. The deeply branched inner dististyle of the male hypopygium suggests a relationship with *T.* (*T.*) *inepta* Alexander and *T.* (*T.*) *idiophallus* Alexander but these latter have the ædeagus again of a structure entirely distinct from any other species described to this date and must be placed in a group of forms distinct from the present fly.

Genus *Gnophomyia* Osten Sacken

Gnophomyia (Gnophomyia) dictena new species.

General coloration black, the anterior pretergites of thorax variegated by a small yellow spot; antennæ, halteres and legs uniformly black; antennæ (male) relatively long for a member of the genus; wings with a blackish tinge, with a broad darker crossband at the level of cord; vein *Cu* less distinctly seamed with darker; *m–cu* at or before midlength of cell *1st* M_2; male hypopygium with caudal border of ninth tergite gently concave, on either side of midline with a compact group of more than twenty-five spinous setæ.

MALE.—Length about 4.5–5 mm.; wing 4.3–5 mm.; antenna about 2.2–2.3 mm.

FEMALE.—Length about 5.5–7 mm.; wing 5.5–6.5 mm.

Rostrum and palpi black. Antennæ black throughout, relatively elongate, especially in male; flagellar segments elongate-fusiform, with long conspicuous verticils, the longest unilaterally distributed. Head black; anterior vertex broad; a slightly developed vertical tubercle.

Thorax uniformly black excepting the very restricted anterior lateral pretergites that appear as oval yellow spots; ventral pleurites more or less pruinose. Halteres and legs uniformly black. Wings with a blackish tinge, with a broad darker crossband at level of cord, extending backward to level of vein *Cu*, the elongate stigma still darker in color; a more restricted blackened wash along vein *Cu*, chiefly in cell *M*; veins black. Venation: *Rs* short and nearly straight, in alignment with R_5 or virtually so, the basal section of the latter thus obliterated; R_{2+3+4} moderately arcuated; cell *1st* M_2 long and narrow, with *m–cu* at or before midlength.

Abdomen black throughout in male, in female the cerci beyond the basal third usually horn-yellow, in cases uniformly black. Cerci long and conspicuous, appearing as compressed blades, their tips subacute; hypovalvæ very short, entirely black. Male hypopygium with the ninth tergite relatively long but the breadth still greater than the length; caudal margin

gently concave, on either side of the median line with a compact group of more than twenty-five strong spinous setæ. Basistyle with mesal face near base provided with a few strong black setæ, in addition to longer, more delicate ones, these strong setæ fewer and weaker than in *coxitalis.* Outer dististyle a simple, gently curved blade, gradually narrowed to the acute spinous tip, the inner edge slightly blackened and roughened, especially at near midlength. Inner dististyle nearly parallel-sided, the outer end truncate and slightly produced on outer face, the style provided with numerous very long, delicate, erect setæ.

Holotype, ♂, Palmar, Manabi, altitude 200 meters, May 19, 1941 (Laddey). Allotopotype, ♀, pinned with type. Paratopotypes, numerous ♂ ♀, May 14–20, 1941 (Laddey).

From other related regional species of the subgenus, as *Gnophomyia* (*Gnophomyia*) *coxitalis* Alexander, *G.* (*G.*) *kertesziana* Alexander, *G.* (*G.*) *mœstitia* Alexander, and *G.* (*G.*) *pallidapex* Alexander, the present fly differs conspicuously in the structure of the male hypopygium, most evidently of the ninth tergite and its armature.

Gnophomyia (Gnophomyia) vitripennis new species.

General coloration of notum black, subnitidous, the pleura more pruinose, variegated with obscure yellow on and near the meral region; antennæ, halteres and legs black; wings vitreous hyaline with conspicuous black veins; R_{2+3+4} only feebly elevated, not arched or subperpendicular as in *arcuata* and allies; ovipositor with cerci elongate, pale basally, the tips darkened.

FEMALE.—Length about 6 mm.; wing 5.5 mm.; ovipositor alone about 1 mm.

Rostrum and palpi black. Antennæ relatively elongate, black throughout; flagellar segments long-oval, the outer ones somewhat shorter; longest verticils slightly exceeding the segments in length. Head black, relatively broad; anterior vertex raised into a low tubercle.

Thoracic notum black, the surface subnitidous, the anterior pretergites restrictedly brightened. Pleura black, conspicuously pruinose, especially on ventral sclerites; meral region more yellow. Halteres black throughout. Legs uniformly black, including coxæ and trochanters. Wings vitreous hyaline, the linear stigma restrictedly darkened; veins black. Venation: Sc_1 ending just beyond level of fork of R_{2+3+4}; Rs oblique; R_{2+3+4} only feebly elevated, not arched as in *arcuata* and allies, in longitudinal alignment with R_{2+3}, which is about three-fourths as long; R_2 relatively faint but distinct, about two-thirds as long as R_{2+3}; cell *1st* M_2 long and narrow, nearly parallel-sided, a trifle shorter than vein M_4 beyond it; *m–cu* about two-thirds its length beyond the fork of M.

Abdomen black; genital shield and distal halves of cerci blackened, the

basal portions of cerci conspicuously whitened; cerci elongate, the length about five times the greatest width, the surface provided with long coarse setæ that occur to the narrowly obtuse tips; hypovalvæ very reduced.

Holotype, ♀, Palmar, Manabi, altitude 200 meters, May 19, 1941 (Laddey).

In the vitreous nature of the wings, the present fly resembles *Gnophomyia* (*Gnophomyia*) *arcuata* Alexander and allies, such as *G.* (*G.*) *diazi* Alexander. It differs conspicuously in the venation, as the unarched R_{2+3+4} and elongate cell *1st* M_2. The bicolored cerci present a peculiar appearance.

Genus *Neognophomyia* Alexander

Neognophomyia consociata new species.

Allied to *pervicax;* general coloration reddish brown, the pleura and pleurotergite patterned with black; femora yellow, the tips narrowly but conspicuously dark brown; wings subhyaline, restrictedly patterned with pale brown, including a seam at cord and an extensive wash in basal third of cell *M;* abdomen with intermediate tergites darkened, the others extensively pale; male hypopygium with the tergal spines black and very conspicuous; ædeagus subtended on either side by narrow, gently incurved apophyses, their tips darkened and obtuse.

MALE.—Length about 5 mm.; wing 4.7 mm.

Rostrum yellowish brown; palpi pale brown. Antennæ relatively long, dark brown, the basal segments slightly more reddish brown; flagellar segments long-oval with long conspicuous verticils. Head light brown; anterior vertex relatively narrow.

Pronotum and mesonotum almost uniform reddish brown, the scutal lobes a trifle darkened, the mediotergite darker behind, the pleurotergite chiefly blackened. Pleura reddish brown, the propleura and anepisternum extensively blackened. Halteres with stem yellow, knob a trifle more infuscated. Legs with coxæ and trochanters reddish brown; femora yellow, the tips narrowly but conspicuously dark brown; tibiæ and basitarsi obscure yellow; outer tarsal segments black; legs with an abundant pale pubescence. Wings relatively narrow, subhyaline, restrictedly patterned with pale brown, including a conspicuous seam extending from the stigma over the anterior cord, becoming obsolete at *r–m;* a conspicuous darkened cloud on basal third of cell *M;* outer end of cell *1st* M_2 very narrowly seamed with brown; veins pale brown, darker brown in the patterned areas, more yellowish in the costal and prearcular fields. Venation: R_2 just before midlength of petiole of cell R_3; *m–cu* at near one-third the length of cell *1st* M_2.

Abdomen with basal tergites pale medially, extensively blackened on sides; succeeding segments pale; tergites four to six, inclusive, conspicuously dark-

ened; segments seven to nine again conspicuously pale; remainder of hypopygium dark; sternites yellow. Male hypopygium with the so-called tergal spines very conspicuous, elongate, heavily blackened, narrowed to the acute tips. Outer dististyle large, its beak relatively slender and blackened, the outer margin with a longitudinal row of about six long setæ; nearer base of style with a conspicuous blackened flange provided with a few coarse setæ. Inner dististyle smaller and even more slender than the outer style, the outer margin and apex with about four long powerful pale setæ. Ædeagus subtended by unusually narrow, gently incurved apophyses, their tips darkened and obtuse.

Holotype, ♂, Palmar, Manabi, altitude 200 meters, May 20, 1941 (Laddey).

The most similar described species is *Neognophomyia pervicax* (Alexander), of Peru, which differs conspicuously in the pattern of the body, wings and legs, and in the details of structure of the male hypopygium, especially of the phallosome. The exact homologies of the so-called tergal spines are still uncertain.

Genus *Cryptolabis* Osten Sacken

Cryptolabis (Cryptolabis) recurvata new species.

Mesonotal præscutum whitish pruinose, with four poorly indicated more reddish brown stripes; antennal flagellum yellow; thoracic pleura with a conspicuous dorsolongitudinal black stripe; scutal lobes with a blackened spot on either side of midline of body; femora yellow, the tips undarkened; wings whitish subhyaline, restrictedly patterned with brown, especially along cord and in axillary region; *Rs* relatively short, oblique; veins R_2 and R_{2+3} in oblique alignment, unusually bent backwards; macrotrichia of cells unusually sparse, restricted to series down the centers of the outer two-thirds of the cells.

FEMALE.—Length about 3.5 mm.; wing 4 mm.

Rostrum and palpi pale brown. Antennæ with the scape and elongate pedicel brown; flagellum abruptly yellow; flagellar segments oval, the outer segments more elongate; verticils long and conspicuous. Head pale brown.

Mesonotum with the ground color whitish pruinose, the præscutum with four poorly indicated, more reddish brown stripes; scutum testaceous medially, the outer portions of lobes weakly darkened; mesal portions of scutal lobes with a conspicuous blackened spot on either side of midline; scutellum infuscated, obscure yellow medially; postnotum darkened, plumbeous. Pleura yellow with a conspicuous black dorsolongitudinal stripe. Halteres pale yellow. Legs with coxæ and trochanters testaceous yellow; femora yellow; tibiæ and basitarsi yellow, the tips narrowly infuscated; remainder of tarsi light brown. Wings whitish subhyaline, restrictedly patterned with brown, the most conspicuous area being a seam along the cord that darkens

the veins; arculus and axillary portion of cell *2nd A* weakly darkened; veins pale, blackened in clouded portions of cord. Macrotrichia of cells beyond cord relatively sparse, confined to the outer three-fifths of cells and occurring as longitudinal rows in the centers of the cells, not adjacent to the veins. Venation: *Rs* relatively short, oblique; R_2 and R_{2+3} in oblique alignment and unusually bent backward, their caudal ends lying more distally than the cephalic ends; basal section of R_5 short; *m–cu* beyond midlength of M_{3+4}.

Abdomen blackened, probably discolored by eggs within body; ovipositor more obscure yellow.

Holotype, ♀, Palmar, Manabi, altitude 200 meters, April 17, 1941 (Laddey).

Cryptolabis (*Cryptolabis*) *recurvata* is closest to *C.* (*C.*) *diversipes* Alexander and *C.* (*C.*) *luteicosta* Alexander, of Central America, differing especially in the coloration of the body and wings, the sparse macrotrichia of the wings, and in the details of venation.

Genus *Molophilus* Curtis

Molophilus (Molophilus) platyphallus new species.

Belongs to the *plagiatus* group; size small (wing, male, under 4 mm.); general coloration brownish gray; male hypopygium with the outer lobe of outer dististyle with apex conspicuously toothed; basal dististyle a stout flattened rod, at apex abruptly narrowed into a strong spine, the tip and mesal face of rod with a dense fringe of long brownish yellow setæ; ædeagus strongly sinuous, unusually broad and flattened.

MALE.—Length about 3.5 mm.; wing 3.8 mm.; antenna about 1 mm.

Rostrum and palpi dark brown. Antennæ (male) of moderate length, black throughout; flagellar segments long-cylindrical with truncated ends, the segments clothed with a short dense pale pubescence; segments with sparse, very elongate verticils, longest on the subbasal segments where they exceed twice the total length of the segment. Head dark brownish gray.

Thorax dark brownish gray, the pretergites scarcely brightened. Halteres weakly darkened. Legs with the coxæ brownish testaceous; trochanters obscure yellow; remainder of legs pale brown, the femoral bases narrowly more brightened; tarsi passing into brownish black; fore tibiæ with a swollen subbasal annulus, well-indicated and slightly darker in color. Wings with a weak brown tinge, the prearcular and costal fields clear yellow; veins brown, those in the brightened portions somewhat lighter in color; macrotrichia brown. Venation: R_2 very faint to scarcely indicated; petiole of cell M_3 about twice *m–cu;* vein *2nd A* sinuous, ending about opposite midlength of *m–cu.*

Abdomen, including hypopygium, dark brown. Male hypopygium with the beak of ventral lobe of basistyle unusually slender, gently decurved. Outer dististyle with the two lobes very dissimilar, the inner spine slender, black-

ened; outer lobe flattened, its apex microscopically toothed. Basal dististyle a stout flattened rod, at apex abruptly narrowed into a long straight spine that is fully one-third as long as the basal portion, this possibly composed of fasciculate bristles agglomerated into a spine; apex and mesal portion of base with a dense fringe of long brownish yellow setæ; at near midlength of style on mesal face with a few strong spinous points interspersed with the setæ; outer face of style with scattered microscopic appressed denticles and a few setigerous punctures. Ædeagus unusually broad, compressed-flattened, strongly sinuous. Phallosomic plate with strongly revolute margins, forming an open cylinder.

Holotype, ♂, Palmar, Manabi, altitude 200 meters, May 12, 1941 (Laddey).

The only other species with the basal dististyle of the male hypopygium at all similar is *Molophilus* (*Molophilus*) *grus* Alexander, which has this structure somewhat similar yet differing in all details, such as the abundant hair-fringe. It further differs in the other details of the male hypopygium, as the outer dististyle and ædeagus, and in the much greater size.

THE NYMPHAL DEVELOPMENT FOR THE ROACH, PERIPLANETA AMERICANA L.*

BY JAMES T. GRIFFITHS AND OSCAR E. TAUBER

Now that the American roach, *Periplaneta americana,* is being widely used as an experimental animal in physiological and toxicological studies, it seems desirable to obtain a thorough understanding of its life history. This paper reports information which deals mainly with the duration and normal number of instars in the development of this species.

In 1917, Marlatt stated that little was known concerning the life history of the American roach. He reported that the nymphal development period for roaches from one egg case varied between 246 and 336 days. Laing (1921) described *P. americana* as one of the common roaches in Great Britain and stated that the nymphal period was supposed to be greater than one year in the United States, but that it had not been worked out in Britain. Later, von Fischer (1927) reported some of her own findings, and compared them with Fibiger's observations. Fibiger found that adulthood was reached in seven to eight months. However, von Fischer claimed that this was too long and that normally adulthood was attained in four and a half to five months, but that nymphal development might extend over a 15-month period. She was able to count 10 molts which were about 14 days apart.

Sein (1923) reported that American roaches in Puerto Rico needed about 350 days in which to become adults. Nigam (1923) noted from seven to nine molts for this species in India, and stated that the nymphal stages lasted for a period of from 300 to 600 days.

More recently, Gould and Deay (1938) found that the males of *Periplaneta americana* took about 20 days longer to reach adulthood than did the females, and that the developmental periods varied between 285 and 616 days with an average of 409 days. They believed that "the American roach apparently molts 13

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times'' and that the first three or four molts were approximately a month apart.

METHODS

Upon hatching, the first instar nymphs were isolated and placed at a constant temperature. Those which were studied to determine the number of molts were kept in cabinets in which the temperature varied within one degree of 29° C. The humidity was partially controlled by saturated NaCl solutions. These roaches were all descended from colonies which had been laboratory reared for several generations. The experimental animals were fed whole wheat bread, banana, and raw beef steak.

Groups of from 25 to 50 first instar roaches were placed in 250-cc. beakers, the tops of which were greased in order to prevent escape of the specimens. These roaches were then observed at daily intervals, or even more often, throughout their nymphal periods. When one molted, it was removed and placed in another container. In this manner, only those roaches which were in the same instar were caged in the same beaker. As the insects neared maturity, fewer and fewer individuals were kept in each container in order to prevent crowding. Thus, the number of days which intervened between hatching and a particular molt was recorded, and in turn, the average number of days per instar could be computed.

RESULTS AND DISCUSSION

It is an extremely difficult task to determine accurately the number of times that a cockroach molts. During the course of these investigations several morphological changes proved to be beneficial in identifying impending or recently completed molts. For several days prior to molting the nymphs appear to be quite slender. Immediately upon molting the roach is, of course, completely white with the exception of the eyes which are dark in color, but within a few hours the integument darkens and becomes light brown. For a day or two following the molt, the edges of the sclerites are darker than the centers and for several days the nymph is rather broad in contrast to its appearance prior to the molt. Cast skins are sometimes helpful, but cannot always be relied upon because they are readily eaten by the molted roach. Gould and Deay reported that in all but the last two instars the

cast skins were devoured. This was not observed in the present experimentation. Cast skins were usually not eaten by the second or third instar nymphs, but after the third instar, all or part of the exuviæ was eaten. Often fragments were helpful in the discovery of newly molted individuals.

The data from five representative groups of roaches observed during their entire developmental stages are listed in Table I. Several other groups were started, but were discarded before their entire nymphal periods were completed. As far as they went, the instar intervals noted for these latter groups were quite similar to those presented in Table I.

Since, as explained above, it was often difficult to determine accurately whether or not a roach had just molted, it was necessary to discard those roaches about which there was any question as to the proper instar. This elimination was an unfortunately necessary procedure, for even with daily or semi-daily observations, molts could not always be definitely noted. Especially was this true among the earlier instars when the developmental rate is more rapid. Therefore, as the experiment progressed, fewer and fewer individuals were retained, and a relatively small number of insects remained by the time adulthood was reached. Only those roaches which became female adults at the completion of the eleventh instar, or male adults upon the completion of the twelfth instar, are included in Table I for those stages beyond the ninth instar. Reasons for this selection are discussed in a later paragraph.

Several facts and trends are readily noted in Table I. The number of individuals decreased throughout the experiment. This is partially explained by the fact that some roaches were discarded. However, there also was a relatively high death rate which could not be adequately explained. Even in stock cages a large number of nymphs fail to reach maturity. It may be that this high developmental mortality is a normal phenomenon of the American roach. Although there is considerable variation between groups, the duration of the early instars averaged less than three weeks. This period was gradually increased with advancing age until the tenth, eleventh, and twelfth stadia averaged more than 30 days. In general, females required 11 instars in

TABLE I

THE DURATION OF INSTARS FOR FIVE REPRESENTATIVE GROUPS OF ROACHES

Molt	A			B			C			D			E			Summary all groups		
	No. ind.	Av. days since hatch	Av. days between molts	No. ind.	Av. days since hatch	Av. days between molts	No. ind.	Av. days since hatch	Av. days between molts	No. ind.	Av. days since hatch	Av. days between molts	No. ind.	Av. days since hatch	Av. days between molts	Total No. ind.	Av. days since hatch	Av. days between molts
1	36	11	11	35	12	12	28	25	25	52	19	19	34	19	19	185	17	17
2	30	25	14	32	32	20	21	50	25	41	35	16	32	35	16	156	35	18
3	28	39	14	29	50	18	21	65	15	39	52	17	30	57	22	147	53	17
4	24	56	17	29	69	19	20	94	29	38	76	24	17	75	18	128	74	21
5	22	74	18	19	89	20	18	114	20	24	102	26	16	97	22	99	65	21
6	18	96	22	16	113	24	15	125	9	13	122	20	15	124	27	77	116	20
7	14	119	23	16	134	21	14	151	26	8	142	20	11	139	15	63	137	21
8	10	143	24	7	139	5	13	180	29	9	180	38	7	179	40	46	164	27
9	7	164	21	7	171	32	10	206	26	10	206	26	7	193	14	41	188	24
10	7	198	35	3	200	29	3	239	33	2	240	34	5	226	33	20	221	33
♀ adult	0	....	......	1	240	40	3	265	26	2	268	28	3	253	27	9	256	30
11	6	231	33	2	241	41	0	....	......	0	....	......	2	271	45	10	248	40
♂ adult	6	267	36	2	275	34	0	....	......	0	....	......	2	328	57	10	290	42

which to complete their development, while males passed through 12 stages.

There were instances in which the number of molts needed for the roaches to become adults was different from that in Table I. However, there is some evidence that 11 and 12 represent the number of instars which females and males, respectively, generally need to complete their development. Support for this conclusion is offered in the following data.

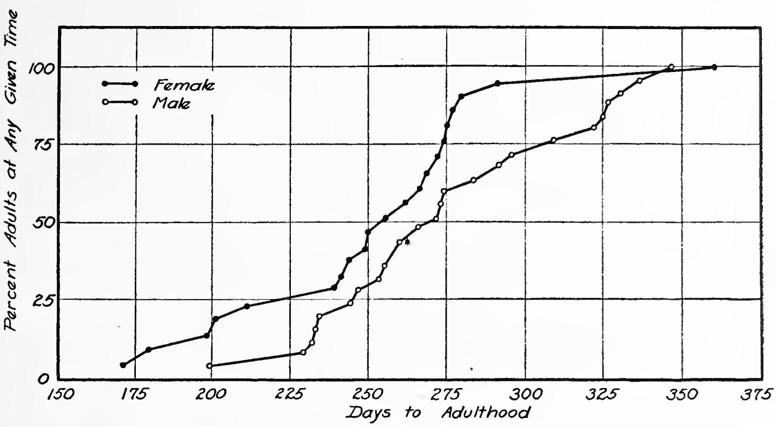

FIG. 1. The rate at which 46 roaches reached maturity. * This represents the emergence of two individuals. All other dots indicate the emergence of one roach and also show the per cent of males or females which have reached adulthood at that given time.

In Figure 1 the rate and time of adult ecdysis for 25 males and 21 females are shown graphically. The first female passed into the adult stage 27 days prior to the emergence of the first male. Also, a female was the last to become an adult. However, there was only one female as opposed to seven males which reached adulthood after more than 300 days. The graph indicates that the females tended to emerge about 25 days earlier than the males. When the emergence dates were averaged, the time was found to be 251 days for the females and 276 days for the males.

Similar results were obtained under different conditions. Several groups of roaches, totaling 62 individuals, were started at 35° C. and later it became necessary to place them at a temperature of 29° C. Approximately half of their nymphal period was

spent at each temperature. For this group, the developmental period averaged 227 days for 11 females (range: 180–411) and 252 days for 10 males (range: 190–367). In a dietary study (unpublished) the authors have found that for 81 male roaches the nymphal period on four different diets averaged 48, 61, 49, and 17 days longer than that for 76 females on the same respective diets. These experiments were performed at room temperature, and the average time for adult emergence was about 365 days which agrees with the work of other investigators. As stated above, Gould and Deay also observed that females became adults in a shorter time than did males. This time difference between the sexes, with a longer nymphal period for males, can be accounted for by longer intervals between molts, or by one or more additional instars.

The facts seem to indicate that the male roach generally requires an extra instar to reach maturity. For 19 males which were reared at 29° C. and whose molts were carefully checked, 10 or 53 per cent became adults upon the completion of their twelfth instar. Six reached adulthood after 11, two after 13, and one after 14 stadia. For 15 females, 12 or 71 per cent became mature after 11 instars, two after 12, and one after 13. Approximately two-thirds of the insects started at 35° C. and then shifted to 29° C. attained maturity after 11 and 12 instars for the females and males, respectively. Therefore, it appears that usually the male needs an additional instar in order to become adult.

The number of molts reported in this paper is not in agreement with that noted by von Fischer, Nigam, or Gould and Deay. Nigam and von Fischer are quite positive in their statements concerning the number of molts, namely seven to nine, and ten, respectively. Gould and Deay were unable to ascertain definitely the exact number, although they report about 13 molts. The period for nymphal development reported by them is similar to that noted for room temperature in the present account. As has been suggested by Griffiths and Tauber (1942), it is entirely possible for an insect which is as universal in distribution as is the American roach, to have developed biological races in many localities of the world. Also, nutritional and temperature changes may markedly affect the developmental period. Thus, it

is to be expected that discrepancies may appear when studies are carried on in widely separated geographical areas, or under different environmental and experimental conditions.

Although no positive explanation can be offered at this time for the increased number of instars required by some individuals of both sexes, some suggestions can be made. Seamans and Woodruff (1939) stated that for the German roach, *Blatella germanica,* the number of molts could be increased by a deficient diet or by bodily injury, such as the loss of an appendage. It would seem entirely probable, therefore, that if in some manner conditions were not altogether satisfactory, the nymphal stadia for certain individuals might be increased above the normal. This is probably a partial explanation for some of the variations in the number of molts in the present experimentation. Although experimental diets may seem adequate, they are often restricted and monotonous. Autotomy, also, might be a contributing factor, for, in isolating and transferring newly molted specimens, forceps were sometimes necessary to secure a lively individual. If too much struggling occurred, a leg was detached.

Another factor which seems to contribute to longer nymphal periods was noted when an attempt was made to rear isolated nymphs at room temperature. Twenty-five newly hatched nymphs were placed in individual 250-cc. containers. They were fed mixtures of Pablum, banana, whole wheat bread, and beef steak. As this is written more than 600 days have elapsed since these observations were started. Only two individuals have reached adulthood. One, a female, completed her final molt after 332 days; the other, a male, after 573 days. Both passed through 12 nymphal instars. Of the other 23, only two are still alive and the most nearly mature of these is a male. Thus, it appears that the American roach does not thrive when an individual is isolated and that several roaches must be together in order for optimum development to occur. Neither a satisfactory explanation nor the optimum number of roaches can be presented at this time, but it seems possible that this isolation or ''under-crowding effect (Park, 1941) may be related to similar results recorded by Chapman (1928), Eigenbrodt (1925), and Pearl (1927, 1932). Eigenbrodt stated that for *Drosophila* the largest individuals were ob-

tained in vials which had a population density of eight to 16 larvæ. Pearl, Miner, and Parker (1927) found that 30 to 50 *Drosophila* per bottle proved to be optimum when longevity was used as a criterion. Chapman (1928) and Pearl (1932), working with *Tribolium* and *Drosophila,* respectively, reported that two pairs of adults per unit volume produced more offspring than did insects at either higher or lower densities.

Regeneration was found to be a relatively common phenomenon. Replacement of tarsal joints, the tarsi and the tibia, cerci, and antennal segments was observed to take place with a single molt intervening between the loss and the regrowth of the appendage. Regeneration is apparently impossible for the adult roach.

Gould and Deay have described a method for determining the sex of immature roaches which is based upon a morphological difference in the sternite of the ninth abdominal segment rather than upon sub-anal stylets. This method has been used by the authors and is quite satisfactory. Subanal stylets are present in both sexes until the late instars, when they appear to be lost in the female nymphs. In the present work, it was noted for the females with 11 molts that the sub-anal stylets usually appeared to be very small in the tenth instar and that they seemed to disappear in the eleventh instar. In the male, they persist through the entire life span.

No definite means for the determination of individuals in a certain instar has been found, but since both the antennæ and the cerci have an increased number of segments with each successive molt, it is entirely possible that a method can be worked out by which the various stadia can be recognized. The last instar is readily identified by the well developed wing pads.

By using data previously reported by Griffiths and Tauber (1942), it is possible to arrive at a comparatively accurate figure for the total life span of the American roach, *Periplaneta americana,* as it exists under laboratory conditions in Iowa. Foods fed to these laboratory-reared specimens seem to have constituted an adequate diet. At room temperature subject to seasonal and diurnal fluctuations, the data in Table II have accumulated.

Fluctuating temperatures during the winter months, with less

heat in the laboratory outside of class hours unquestionably prolongs the developmental period. Natural variations in the length of the nymphal stage plus possible contributing environmental factors generally carry the immature stages along for from nine to 13 months, or even longer. A complete reproductive cycle could possibly occur within a minimum of 243 days $(35 + 199 + 9)$, but would probably average about 434 days $(53 + 365 + 16)$. Also, it could take as long as 573 days $(72 + 465 + 36)$.

TABLE II

NORMAL EXTENT OF VARIOUS PHASES IN THE LIFE SPAN OF THE AMERICAN ROACH

Incubation of eggs (days)	Nymphal development (days)	Preoviposition period (days)	Adulthood (days)*		
			♀	♂	♀ & ♂
Range 35–72*	199–465†	9–36*	90‡–706	90–362	90–706
Avg. 52.7*	365†	15.6*	225	200	213

* Data from Griffiths and Tauber (1942).
† These figures have been determined from specimens fed on what is believed to be an adequate mixture. Roaches on inadequate diets may take from two to three years or longer in order to complete their development. (Experiment in progress.)
‡ This minimum was arbitrarily selected for both males and females by discarding those individuals which died within 90 days after the final molt. Such a selection was made to assure the observation of healthy, uninjured specimens.

The entire life span from egg to the "natural" death of a presumably healthy adult might cover a minimum of 324 days $(35 + 199 + 90)$. An average life span would probably be about 631 days $(53 + 365 + 213)$. However, if an individual roach enjoyed maximum longevity, the life span could be about 1243 days $(72 + 465 + 706)$.

CONCLUSIONS

All conclusions are concerned with the American cockroach, *Periplaneta americana* L.

1. At 29° C., the female roach generally requires 11 and the male 12 instars before reaching adulthood. More stadia are necessary for some individuals. It is suggested that this increase

may be due to unfavorable environmental conditions or bodily injury.

2. The males averaged 276 (range: 198–346) and the females 251 days (range: 171–360) to complete their development at 29° C. Similarly, at room temperature the females became adults sooner than did the males.

3. Under laboratory conditions and at room temperature, a complete reproductive cycle ("egg to egg") may be passed in about 243 days, but normally it takes about 15 months. The entire life span (egg to "natural" death) usually extends over a period of about 630 days, but may last for more than 1,200 days.

4. The regeneration of certain parts such as portions of lost appendages is possible throughout nymphal development.

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TAXONOMIC OBSERVATIONS ON BEES WITH DESCRIPTIONS OF NEW GENERA AND SPECIES (HYMENOPTERA; APOIDEA)

BY CHARLES D. MICHENER

This paper is published at this time in order that the new generic and subgeneric names proposed can be used in a forthcoming paper on the classification of the Apoidea.

Genus HYLÆUS

Popov [1939, Comptes Rendus (Doklady) Acad. Sci. U.R.S.S., 25: 167–170] has recently reviewed the subgenera of this large genus. Our North American fauna, which is rather meagre as compared with that of the Old World, contains three named subgenera, *Hylæus* Fabricius s. str. (*cressoni* division of Metz), *Prosopis* Fabricius (*modestus* division of Metz), and *Paraprosopis* Popov (*asininus* division of Metz). In addition to these there are two other small and as yet unnamed Nearctic subgenera. They are characterized as follows:

Metziella new subgenus

Clypeus of male about as long as broad, anterior tentorial pits near middles of lateral margins; antennal scape not greatly thickened. Seventh abdominal sternum of male with apical lobes rather small, although slightly larger than usual in the subgenus *Prosopis,* not so produced and pointed apically as in that group, and abundantly hairy. Eighth sternum of male much as in *Cephalylæus,* median basal process (spiculum) broad and short, median apical process about half as long as disc of sternum, pointed apically, without hairs. Coxopodites of male genitalia not expanded basally.

Type: *Prosopis potens* Metz.

This subgenus is closest to *Prosopis* s. str., but the reduced eighth sternum and the broad clypeus indicate a possible relationship to *Cephalylæus.* So far as known it includes only the type species.

Cephalylæus new subgenus

Clypeus of both sexes about as broad as long or broader, male with anterior tentorial pits above middle of clypeus; supraclypeal area in male with

a longitudinal elevated ridge; antennal scape of male greatly expanded, at least as broad as long; seventh abdominal sternum of male with apical lobes small, broadly fused with distal part of sternum, and hairy on outer margins; eighth sternum of male reduced, basal process (spiculum) broad and rather short, distal process very short, hairless, acutely pointed. Coxopodites of male genitalia large, expanded basally and apically, apices each with a strong hairy ridge starting at inner apical angle and extending across the apex, basally along outer margin, thence across middle of ventral surface of gonocoxite to terminate at a small inner lobe.

Type: *Prosopis basalis* Smith.

This very distinct subgenus resembles certain Old World forms of the subgenus *Abrupta* in the enlarged male antennal scape, form of the clypeus and supraclypeal areas, etc., but differs from that subgenus in the small apical lobes of the seventh sternum, the very small and bare apical process of the eighth sternum of the male, and the form of the male genitalia.

In addition to *H. basalis* (Smith), this subgenus includes *H. nunenmacheri* Bridwell. It seems worth pointing out that while Metz's figures of the genitalia of other species are dorsal views, his figure of those of *H. basalis* is a ventral view.

Genus PERDITOMORPHA

A topotypical specimen of *P. brunerii* Ashmead, the type species of this genus, was kindly loaned me by Dr. T. D. A. Cockerell. The glossa is short, bilobed much as in *Colletes*. Indeed the genus is apparently closely related to *Pasiphæ*, with which it agrees in wing venation, although it has usually been placed in the Panurgidæ.

Genus CAMPTOPŒUM

This is an Old World genus, characterized by having the subantennal plates considerably longer than broad as in *Epimethia, Panurginus, Pseudopanurgus, Psænythia, Protandrena,* etc. The numerous South American forms described in *Camptopœum* should all be placed elsewhere. One group having a submetallic abdomen without integumental markings has been separated as *Acamptopœum* (=*Liopœum*) by Cockerell. Certain other species (*brasiliense* Schrottky, *argentium* Friese) are to be placed in *Calliopsis* or its subgenus *Parafriesea.* The remaining South American species which I have examined [*nomadoides* Spinola,

trifasciatum Friese, *steinbachi* Friese, *ochraceum* Friese, *herbsti* Friese, *flaviventris* Friese, *difficalis* Friese, and *bifasciatum* (Friese) (described as *Psœnythia*)] agree with the North American *Nomadopsis* in the short subantennal areas, in the slightly produced median part of the apical margin of the clypeus, the produced portion overhanging the groove from which the apical fringe of long hairs arises, in the narrow stigma, in most cases in the shape of the marginal cell, etc. There is more diversity among these South American forms than among the North American *Nomadopsis*. In most of them the inner orbits diverge below, unlike those of the North American species. It seems best to include the South American species in the *Nomadopsis* at least until a satisfactory subgeneric division of that genus is proposed, and *Spinoliella* (type: *C. nomadoides* Spinola) must then be placed as a synonym of *Nomadoides*. As will be explained elsewhere, the North American species usually included in *Spinoliella* are to be called *Nomadopsis*.

The single North American species described as *Camptopœum* (*C. semirufum* Cockerell) is a *Pseudopanurgus* [*P. abdominalis* (Cresson)].

Genus CALLIOPSIS

Perissander new subgenus

This subgenus resembles typical *Calliopsis* in the short, broad subantennal plates, the slender stigma, whose length from its base to base of vein r is little longer than the prestigma, at least in the female, thus differing from *Hypomacrotera*, in which the stigma is longer; abdomen without yellow integumental markings but with apical hair bands on the segments. The female, indeed, is scarcely separable from other *Calliopsis* except for the red abdomen and the slightly more parallel-sided distal part of the marginal cell. The male, however, is very unusual, as indicated below.

Middle tarsi slender, about three times as long as middle tibiæ; forewings bent abruptly posteriorly beyond apex of marginal cell, the wing tip being drawn out into a broad, posterior process; apices of forewings blackish; marginal cell elongate, slender, parallel-sided apically, much longer than cell 1st · M (Ross terminology); stigma more elongate than in female.

Type: *Calliopsis* (*Perissander*) *anomoptera* n. sp.

Calliopsis (Perissander) anomoptera new species

MALE: Length 5 mm. Pubescence sparse, yellowish white. *Head* considerably broader than long; clypeus but slightly protuberant, anterior margin

broadly and shallowly emarginate medially, angles on either side of emargination rounded; inner orbits slightly converging below; head shining, rather sparsely punctate, except for broad zone across face immediately in front of ocelli which is finely and closely punctate; face yellow nearly to level of anterior ocellus, the yellow indented on each side near eye by the small black facial fovea; antennæ yellow, flagellum more or less orange; labrum yellow; mandibles yellow, apices dark red; labial palpi short, first segment a little shorter than next two together, second segment but little longer than third which is subequal to fourth. *Thorax* black, finely punctate, scutum and scutellum rather closely so, dorsal area of propodeum finely roughened, the following parts yellow: posterior lobes of pronotum, posterior margin of pronotum above (yellow broken medially), area on posterior margin of pronotum below tubercle, tegulæ (except for translucent parts), ventral surface of thorax, lower half of mesepisternum, yellow extending up as a slender band to subalar pit, and legs (distal parts of middle and rear tarsi pale brownish); middle basitarsi longer than middle tibiæ and as long as next two tarsal segments together; posterior basitarsi longer than segments two to five together; wings clear, except for dusky portion from near apex of marginal cell to wing tip. *Abdomen* finely punctate, red, terga four to seven black (fourth reddish in holotype, nearly as red as third in some paratypes); posterior margins of terga two to five with bands of white pubescence.

FEMALE: Length 5 mm. Punctation, form of clypeus, etc., similar to male. *Head* black, the subantennal areas, supraclypeal area, paraocular areas (pale areas narrowed at level of antennæ and irregularly truncated at level of lower margin of facial foveæ) and large area in upper part of clypeus cream color; labrum black, mandibles black with slight reddish tinge; antennæ black, under side of flagellum yellowish brown. *Thorax* black, posterior lobes of pronotum, broken lines on posterior dorsal margin of pronotum, and areas on tegulæ cream color; legs black, basal portions of outer side of fore and middle tibiæ cream color. *Abdomen* red, fifth and sixth terga black, posterior margin of fourth infuscated; posterior margins of terga one to four with with more or less broken bands of white pubescence; pubescence of fifth and sixth terga fuscous.

Holotype: male, allotype, female, and seven paratypes from Picacho Pass, Arizona, August 7, 1940, on a small *Euphorbia* (C. D. Michener). Two female paratypes from ten miles south of Tucson, Arizona, August 8, 1940 (C. D. Michener). I have also seen a female of this species from New Mexico. The holotype and allotype will be placed in the collection of the American Museum of Natural History, paratypes, in the collections of the California Academy of Sciences and the author.

This is the only known species of *Calliopsis* with a red abdomen, other forms so characterized described in this genus having been

removed to *Pseudopanrugus* and *Hypomacrotera.* The dark tips of the wings of the male suggest *Hypomacrotera,* but the relatively short stigma and short marginal cell in the female indicate the relationship of this form to *Calliopsis.* Many male *Calliopsis* exhibit somewhat elongate middle tarsi, a condition reaching its extreme in *C. anomoptera* but not found in *Hypomacrotera.*

Genus CTENOPLECTRA

The genus *Ctenoplectra,* usually credited to F. Smith (1857), was described briefly by William Kirby and the original description should be cited thus: *Ctenoplectra* Kirby, 1815, in Kirby and Spence, Introd. Ent., 3: 681.

Genus CONANTHALICTUS

This genus, described as a subgenus of *Halictus* by Cockerell in 1901, is apparently separable into at least two distinct subgenera. *Conanthalictus* s. str. contains *C. conanthi* Cockerell and *C. cotullensis* Crawford from New Mexico and Texas and may be recognized by the elongate oval head, with the antennæ separated from the epistomal suture by less than the width of an antennal socket, the antennal bases twice as far from the ocelli as from the anterior margin of the clypeus, the ocelli above a line drawn between the summits of the eyes, and the glossa rather elongate. Crawford's *Sphecodosoma* may be closely related to *Conanthalictus* s. str. The other subgenus of *Conanthalictus* may be characterized as follows:

Phaceliapis new subgenus

Head seen from front broader than long; antennæ separated from epistomal suture by diameter of antennal sockets; antennal bases scarcely one and one-half times as far from ocelli as from anterior margin of clypeus; line between summits of eyes passing through ocellar triangle; glossa about three times as long as broad.

Type: *Conanthalictus bakeri* Crawford.

In addition to the type species, this subgenus includes *C. macrops* Cockerell, *C. wilmattæ* Cockerell, *C. seminiger* Michener and several undescribed forms, all from California. All collect pollen from flowers of the Hydrophylaceæ, most are oligolectic on *Phacelia.*

Genus PARANTHIDIUM

Mecanthidium new subgenus

Resembling *Paranthidium* s. str. in the straight subantennal sutures, long and nearly straight apical margin of the mandibles of the female, three-segmented maxillary palpi, rounded scutellum, presence of arolia, etc., but differing in the large size, elongate form, and the following other characters: second recurrent vein distad from second transverse cubitus by only two to three times width of a vein; seventh abdominal tergum of male with lateral lobes reduced to small inconspicuous angles, median portion produced to a long, somewhat downcurved, beaklike process tapering to a narrowly rounded apex; posterior lobes of pronotum each with a transverse lamella, smaller than in *Dianthidium* and reaching mesad of lateral extremities of mesoscutum; anterior face of mesepisternum separated from lateral face by weak carina.

The last two characters are shared by a few species of *Paranthidium* s. str.

Type: *Paranthidium* (*Mecanthidium*) *sonorum* n. sp.

Mr. H. F. Schwarz has kindly pointed out to me that *Dianthidium macrurum* Cockerell from Mexico is also a *Mecanthidium.* This subgenus seems to have certain features in common with the Old World *Rhodanthidium,* the form of the apex of the male abdomen apparently being similar. However, the gonocoxites are slender, not notched apically as in *Rhodanthidium.*

Paranthidium (Mecanthidium) sonorum new species

MALE: Length 17 mm. (abdomen straightened, 14 mm. in paratypes with curled abdomens). Color brownish red; tarsi yellowish; distal portions of antennæ fuscous; small inverted V-shaped black area enclosing ocelli, its arms extending toward antennal bases and (in paratypes) small blackish areas below antennal bases. Pubescence short, sparse, yellowish white. *Head* dull, finely and densely punctured; margin of clypeus broadly truncate, truncation crenulate with about eight small low, rounded convexities; mandibles tridentate, the low median tooth about midway between acute apical tooth and inner apical angle, which is rather sharp, right angular; labrum with two small adjacent basal tubercles one on either side of midline. *Thorax:* Scutum exceedingly dull, even more finely punctured than head; scutellum and axillæ punctured about as head; mesepisternum and upper half of metepisternum coarsely and closely punctate; lower half of metepisternum impunctate, finely lineolate; propodeum more finely punctate than mesoscutum but with small lineolate spaces between punctures in some areas. Wings dark brown, rather opaque. *Abdomen* with terga but little more finely punctured than mesepisternum and closely so, posterior margins narrowly impunctate; seventh tergum with small rounded lobe at each side and huge

median downcurved process tapering to narrowly rounded apex, and provided with longitudinal median dorsal impunctate elevated line; second sternum with posterior part transversely elevated, shining, impunctate; sixth sternum with two broad apical lobes separated by shallow notch; next sternum with two long, broad, rounded lobes separated by emargination as wide as a lobe.

FEMALE: Similar to male but basitarsi red, apical half of flagellum black, black areas below antennal bases larger, extending down to epistomal suture; clypeal denticulations four, larger than in male, in median part of truncation; cutting edge of mandible long, nearly straight with very feeble undulations indicating positions of teeth; sixth abdominal tergum broadly rounded, untoothed, slightly exceeded by sixth abdominal sternum; scopa rather sparse, pale yellowish brown.

Holotype: male from Estrella, Sonora, Mexico, October 2, 1933. Allotype, female from Estrella dist., Alamos, Sonora, Mexico, October 2, 1933. One female paratype, labelled as is the allotype; one male paratype labelled Sonora, Mexico, October 2, 1933, and one male paratype labelled merely Arizona. It seems almost certain that all but the last specimen are from the same locality. All are from the collection of Mr. G. E. Bohart, through whose kindness they have been made available to me. The holotype and allotype will be placed in the collection of the California Academy of Sciences, a paratype in the American Museum of Natural History, and the other paratypes in the Bohart collection.

This species differs from other American Anthidiini by the uniform red color, the dark color of the wings, etc.

Chalepogenoides new genus

Holmberg in 1903 (Anal. Mus. Nac. Buenos Aires, (3)2: 416) described the genus *Chalepogenus*. It agrees with *Lathanomelissa* and *Tapinotaspis*, described in the same paper, in the unmodified posterior legs of the male and the slender hind tibial spurs of both sexes. Numerous species of *Tetrapedia* s. l. (the type species of which has modified posterior legs in the male and broad, strongly pectinate inner hind tibial spurs in both sexes) exhibiting these characters have in recent years been transferred to Holmberg's genera, particularly to *Chalepogenus*. Holmberg's genera, according to his description and key, agree with *Tetrapedia* in having the second abscissa of vein M-Cu of the posterior wings little if any longer than vein cu-v. At least some of the species which have recently been placed in *Chalepogenus*,

however, have the second abscissa of M + Cu two or three times as long as the nearly transverse cu-v, thus resembling *Exomalopsis* and *Ancyloscelis.* These latter species are therefore to be placed in *Chalepogenoides,* described as follows:

Small, shining, sparsely punctate forms with ample, infuscated wings, and often white or yellow face markings, at least in the male. *Head* with clypeus somewhat protuberant, lower lateral portions bent backward; summit of vertex but little elevated above summits of eyes; posterior margin of vertex limited by a carina which fades away at sides; first flagellar segment broader than long, most of flagellar segments a little longer than broad; labrum nearly twice as broad as long, apex subtruncate; mandibles bidentate; maxillary palpi six-segmented, one-half as long as postpalpal part of galea, second segment longest; paraglossæ very short; first segment labial palpi twice or more than twice as long as second. *Thorax* high, propodeum without horizontal basal area; anterior basitarsi flat, concave beneath, at least as broad as and about two-thirds as long as tibiæ; middle basitarsi nearly as long as middle tibiæ and as remaining tarsal segments together, as broad as tibiæ; middle coxæ markedly shorter than distance from summits to hind wing bases; middle tibial spur more than one-half as long as basitarsus, slender, abruptly bent at tip; posterior basitarsi as broad as rear tibiæ but shorter than the latter, as long as remaining tarsal segments together; posterior tibial spurs two on each leg in both sexes, slender; claws cleft in both sexes, inner teeth slightly shorter in females than in males; arolia present; posterior margins of middle and hind tibiæ and basitarsi of male with dense fringe of long, conspicuously plumose hairs; scopa consisting of long simple hairs mixed with shorter, conspicuously plumose hairs as in *Tetrapedia;* wings with stigma large, much broader than distance from inner margin of prestigma to wing margin, extending far beyond base of vein r; submarginal cells three, first and third subequal in length on posterior margins, third narrowed one-third to nearly one-half toward marginal cell, second shorter than others, rather strongly narrowed toward marginal cell; marginal cell much longer than distance from apex to wing tip, apex bent rather strongly from wing margin and pointed, edges of cell subparallel throughout much of their lengths; wings hairy throughout, not papillate; posterior wings with jugal lobe about one-third as long as vannal lobe (both measured from wing base), vein cu-v somewhat oblique, about one-half as long as second abscissa of M + Cu, which is about two-thirds as long as vein M. *Abdomen* with pygidial area of male absent, the seventh tergum being produced to an acute point, pygidial area of female reduced, its lateral bounding lines meeting well before apex of tergum, which is broadly rounded apically; sixth sternum of male with longitudinal median ridge sometimes elevated to a spine; seventh sternum of male with a pair of ornate apical lobes; eighth sternum of male with deep median apical notch; male genitalia with flattened gonostyli about as long as gonocoxites.

Type: *Chalepogenus leucostoma* Cockerell.

This genus includes also *C. mœstus* (Cresson), *lugubris* (Cresson), *calcaratus* (Cresson), *abdominalis* (Cresson), and probably some of the other species recently placed in *Chalepogenus*, such as *testaceus* (Smith), *flavus* (Smith), *hypoleucus* Cockerell, *amplipennis* (Smith), *bunchosiæ* (Friese), *glaberrima* (Friese), *nigripes* (Friese).

The only species of true *Chalepogenus* which I have seen is *globulosus* (Friese) (from Tobogal, Panama, det. Cockerell). Aside from the character of posterior wing venation, this form differs from *Chalepogenoides* in the presence of a pygidial area in the male, the larger pygidial area of the female which reaches the posterior margin of the tergum, and the larger jugal lobe of the posterior wings (one-half as long as vannal).

Chætostetha new genus

In this genus the middle tibial spurs and the inner spurs of the posterior tibiæ are broadly pectinate, much as in *Tetrapedia*, while the posterior wing venation is as in *Exomalopsis*, *Ancyloscelis*, and *Chalepogenoides*.

Rather large, shining forms. *Head* with clypeus somewhat protuberant, lower lateral portions bent backward; vertex little elevated above summits of eyes; posterior margin of vertex not delimited by a carina; first flagellar segment much longer than broad, longer than any other segment except last, but much shorter than scape; labrum much broader than long; mandibles with subapical inner tooth; maxillary palpi about one-half as long as galeæ, six-segmented, first segment shortest, second longest; first segment of labial palpi more than twice as long as second. *Thorax* high, propodeum virtually without horizontal basal area; anterior basitarsi broad, flattened, concave beneath; middle coxæ distinctly shorter than distance from summits to posterior wing bases; middle tibial spurs broadly pectinate except for slender hooked tips; posterior basitarsi short, as broad as tibiæ; inner hind tibial spurs broadly pectinate with fewer, more widely separated teeth than in *Tetrapedia;* claws cleft; arolia present; under surface of thorax and middle and posterior trochanters clothed with numerous, very coarse, unbranched bristles with strongly hooked apices; wings with stigma of moderately large size, broader than distance from inner margin of prestigma to wing margin, vein r arising basad of middle of stigma; submarginal cells three, first and third subequal in length on posterior margins, third narrowed less than one-half toward marginal cell, second shorter than others, somewhat narrowed toward marginal; marginal cell much longer than distance from apex to wing tip, apex bent gradually away from wing margin for nearly half length of cell; margins of cell subparallel for much of its length; wings hairy throughout, not papillate; posterior wings with jugal lobes about one-third

as long as vannal (measured from base), vein cu-v somewhat oblique, less than one-half as long as second abscissa of M + Cu, which is little shorter than vein M. Abdomen with first four sterna covered with uncinnate bristles similar to those of under surface of thorax; pygidial area (of female) very large, considerably broader than long, bluntly pointed, transversely lineolate.

Males of this genus are unknown to me.

Type: *Exomalopsis pyropyga* Friese.

This genus contains also *Chætostetha saussurei* (Friese) (described as a *Tetrapedia*). *C. pyropyga* and *C. saussurei* differ from both *Tetrapedia* and *Exomalopsis* in size and habitus, as well as in numerous structural characters.

Genus **ANTHEDONIA** new name

This name is proposed for *Anthedon* Robertson, 1900, Trans. Acad. Sci. St. Louis, 10: 53, not Agassiz, 1846.

Genus XYLOCOPA

Ma (1938, Rec. Ind. Mus., 40: 265–329) has revised the Indian species of *Xylocopa* and has proposed a number of new subgenera, the names of two of which are preoccupied.

Maiella new name for *Orbitella* Ma, 1938, Rec. Ind. Mus., 40: 305, not Douville, 1915.

Ctenoxylocopa new name for *Ctenopoda* Ma, 1938, Rec. Ind. Mus., 40: 285, not McAtee and Malloch, 1933.

NYMPHALIDÆ OF THE ANTILLES (LEPIDOPTERA, RHOPALOCERA)

BY WILLIAM P. COMSTOCK

COLOBURA DIRCE LINNÆUS AND ANTILLEAN SUBSPECIES

Colobura Billberg.

Colobura Billberg (1820) 79. *Gynæcia* Doubleday (1850) 248, pl. 29, fig. 1. *Colobura* Aurivillius (1882) 90.

Genotype: *Papilio dirce* Linnæus, 1758.

Both *Colobura* and *Gynæcia* have the single species *dirce* as genotype. *Najas* Hübner (1807), as originally published, applied only to *themis* Hübner, a species which is not congeneric with *dirce,* although Hübner later included *dirce* in the genus *Najas.* Hemming (1934: 90).

The description of *Papilio dirce* Linnæus (1758: 477) has the note: "M. L. U.," meaning in the Museum Ludovicæ Ulricæ and the habitat "Calidis *regionibus.*" Clerck (1764: pl. 36, fig. 3) figured the species (under the name of the synonym *bates*) from the Museum Ludovicæ Ulricæ collection, thus determining the Linnæan name. Aurivillius (1882: 90) mentions the type which presumably still exists. This is the butterfly which flies generally throughout South and Central America. Its continental occurrence was recognized by the earlier authors but the first reference to it in the Antilles was by Doubleday (1850: 248).

It must be borne in mind that this species has a very complex underside pattern which is subject to variation in any one locality as is well shown by long series from Colombia, Ecuador and Peru. At the northern end of the continental range, the Mexican population varies slightly from that farther south in having the dark lines on the underside slightly heavier in some individuals. This is a step toward the marked changes that occur in the various Antillean populations which differ as a group in having definitely heavier underside markings. The types are all in the collection of The American Museum of Natural History, except as otherwise noted.

Colobura dirce clementi, new subspecies.

SIZE AND SHAPE: the male has a forewing from 33 to 37 mm. in length with a nearly triangular shape, the outer margin being very slightly convex from the apex to Cu_1. The hindwing is well rounded at the apex and prolonged between Cu_2 and 2A to form a broad, blunt lobe. In shape the males do not differ from continental males of *dirce* but the specimens average slightly larger.

GROUND-COLOR: this is black-brown on the upperside but nearly black in the apical half of the forewing. The color is a little deeper than in continental *dirce.* The underside ground-color is cream to yellow but much obscured by the pattern. There are traces of a pinkish tone in some of the hindwing areas which are normally cream in *dirce.*

MARKINGS: there is on the upperside of the forewing a lemon-yellow, oblique, irregular band varying in width from 4 to 6 mm., which meets the costa near the center and extends toward the tornus but does not quite reach the margin. The subapical yellow spot near the costa, present in *dirce,* is usually absent. In the anal lobe of the hindwing there are two joined black spots centered with a few blue scales. The underside of the forewing has the oblique band of the upperside repeated in cream-white. The apical area beyond the band is heavily but irregularly barred with dark brown, the bars merging together in blotches to make this area very heavily marked. In the central bar there are two, in some specimens three, black spots centered with a few blue scales. The wing area basad of the band is also heavily marked but the barred pattern is clearly retained and not suffused. In these respects Cuban specimens are much more intensely marked than continental *dirce.* The hindwing is also heavily barred but not suffused. Paralleling the outer margin there are three brown lines standing out more sharply on the yellow ground than in *dirce.* Basad of these there is a strongly defined, wedge-shaped, brown area which contains three subocellate spots diminishing in size from the costa. These spots are black, blue centered, and the largest and uppermost is tinged basad with maroon. The whole wing pattern is much more intense than is usual in *dirce.*

Types all from Cuba: Holotype, male, Santiago de Cuba, July, 1934. Paratypes: 3 ♂, Santiago de Cuba, July, 1934; 2 ♂, Sierra Maestra, July, 1934; 2 ♂, Habana, July, 1934 and 1935. These specimens were presented to the Museum by Mr. Frederic E. Church of New York. They were collected by H. Frère Clément for whom this new subspecies is named because of his great interest in Cuban Lepidoptera.

In the collection of the Museum of Comparative Zoology, Cambridge, Mass., there are the following paratypes: 2 ♂, Havana, July, 1935; ♂, Rangel, Pina del Rio, July 15, 1935; ♂, Cuchillo de Guayamas, Oriente, July 22, 1936.

The following four paratypes are in the collection of Dr. Charles T. Ramsden, in Santiago de Cuba: Santa Maria de Loreto, elevation 2,000 feet, June 1, 1908; Central "Romelie," east of Guantánamo City, in the plain, July 8, 1908; "Sierra de Canasta," west of Guantánamo City, elevation 300 feet, November 19, 1914; Bayate, Guantánamo, 20 to 30 miles N. W. of Guantánamo City, September, 1920.

Colobura dirce avinoffi, new subspecies.

SIZE AND SHAPE: the length of forewing in males is from 30 to 35 mm. and in females from 33 to 35 mm. The shape of the wings in males is the same as in *dirce* and *clementi.* In females the outer margin of the forewing is more evenly rounded from the apex to the tornus and is not slightly restricted below Cu_1 as in males, a sexual character true of all subspecies.

GROUND-COLOR: on the upperside this is slightly paler than *dirce* and distinctly paler than *clementi* in the males. The females are likewise paler than *dirce.* The underside shows a great distinction in ground-color for in the Jamaican population the coloring is pale lilac while in other subspecies it is cream or yellowish white. This is evident in the apical and basal areas of the forewing and over the entire hindwing except the submarginal yellow band which is thus more emphasized. Superficially the underside has a smoky appearance more noticeable in some specimens than in others with the females tending to be paler.

MARKINGS: on the upperside the marking is like *dirce* with the yellow costal spot present, not absent as it usually is in *clementi.* On the underside the dark brown markings are a little heavier than in *dirce* and much less pronounced than in *clementi.* The black, blue-centered spots of the central apical brown bar are slightly more evident than in *clementi* and in the hindwing the subocellate spots show more blue scaling.

Types all from Jamaica: Holotype, male, Bath, St. Thomas, April 3, 1931; Allotype, female, Reading, St. James, January, 1939. Paratypes: 3 ♂, Bath, St. Thomas, April 3–4, 1931; 1 ♂, Constant Spring, St. Andrews, January 24, 1920; 1 ♀, Reading, St. James, January, 1939.

The following paratypes are in the collection of the Carnegie Museum, Pittsburgh, Pa.: 1 ♂, 1 ♀, Bath, St. Thomas, August 2, 3, 1931; 1 ♂, John Crow Hill, St. Thomas, July 3, 1937; 1 ♂, Pass or Gap Dist., Cuna Cuna Trail, St. Thomas, July 5, 1937.

The following paratypes are in the collection of the Museum of Comparative Zoology, Cambridge, Mass.: Baron Hill, near Jackson Town, 1,200 feet, 3 ♂, August; ♀, September.

The following paratypes are in the collection of Mr. Frederic E. Church, New York, N. Y.: 3 ♂, Reading, St. James, December 22, 30, 1938; January 20, 1939; ♀, Montego Bay, January 3, 1939.

A description and figures of this Jamaican subspecies appeared unnamed in Sloane (1725, 2: 218, pl. 239, figs. 3, 4); a reference not cited by Linnæus.

This subspecies is dedicated to Dr. A. Avinoff because of his extensive study of the butterflies of Jamaica.

Colobura dirce wolcotti, new subspecies.

SIZE AND SHAPE: the length of forewing in males is from 33.5 to 35.6 mm. and in the females 35.6 to 37.7 mm. The wing shape of both sexes respectively is the same as *dirce*.

GROUND-COLOR: on the upperside this is brown and on the underside cream with yellow areas like *dirce*.

MARKINGS: on the upperside, the subapical yellow spot is absent as in *clementi*, thus differing from *dirce*. The underside of the forewing has heavier brown markings in the apical and basal areas than *dirce* but the apical markings are not suffused as in *clementi*. The hindwing is also heavily marked as in *clementi* with pinkish tones replacing some of the cream areas of *dirce*. The blue spots of the central bar of the forewing are obsolete but the subocellate spots of the hindwing are about as in *clementi*. It is distinguished from *avinoffi* by the lack of the pale lilac coloring.

Types: Holotype, female, Mayaguez, Puerto Rico, July 24–29, 1914. Paratypes: 1 ♂, Consumo, between Mayaguez and Las Marias, Puerto Rico, March 7, 1935; 1 ♂, 1♀, Fond Parisien, Haiti, February 19–20, 1933.

The following are in the collection of Cornell University, Ithaca, N. Y.: allotype, male, Lares, Puerto Rico, December, 1930; paratype, ♂, Largo dos Bocas, Puerto Rico, March 10, 1940.

The following paratypes are in the collection of the Museum of Comparative Zoology, Cambridge, Mass.: 5 ♂, 1 ♀, Cap Haitien, Haiti; ♂, Port au Prince, Haiti, October 9.

This subspecies is named for Dr. George N. Wolcott, chief of the entomological staff of the University of Puerto Rico, who has made so many valuable contributions to the entomological literature of that island.

The subspecies *walcotti*, the most remote geographically, appears the least differentiated from *dirce* of the continent. I have been unable to find any records of the capture of *dirce* in the Lesser Antilles but it occurs in Trinidad with the same facies as specimens from the Guianas.

EUNICA TATILA (HERRICH-SCHÄFFER) AND EUNICA TATILA TATILISTA KAYE

Cybeldis tatila Herrich-Schäffer (1853) 54, pl. 17, figs. 69–72. "Am.mer."

Eunica tatila Herrich-Schäffer (1864) 162.

Eunica cœrula Godman and Salvin (1877) 64. Guatemala.

Eunica tatila and *cœrula* Godman and Salvin (1883) 1: 229, pl. 23, fig. 14.

Eunica tatila and *cœrulea,* Seitz (1915) 484.

Herrich-Schäffer described *tatila* by the publication of four figures appearing in the second group of plates of his work which were issued in 1853. The text referring to *tatila* (54, dated April, 1858) consists of the line: "*tatila.* H-S. Exot. II. f. 69–72.—Am. mer." The obvious interpretation of the locality is Central America.

In 1864 Herrich-Schäffer published his paper on Cuban butterflies which were sent to him by Gundlach. Writing of *tatila* he says: "Herr Gundlach received this as *maria* from H. Verreaux." This introduces a name which seems to be *nomen nudum* for I can find no other mention of it. Herrich-Schäffer's use of it is synonymous. He also mentions three variations in the underside pattern but apparently determined all Cuban specimens as *tatila.* He most certainly did not change the type locality of *tatila* to Cuba.

Godman and Salvin in 1877 described *Eunica cœrula* from one male from Guatemala, differentiating this specimen from "*E. tatila*—ex. Haiti." Later (1883) in the Biologia they made a correction; recognized *tatila* and made their *cœrula* a synonym. They include in their localities for *tatila,* Mexico, Guatemala, Honduras, Colombia, Haiti and Cuba, but for the last they refer to the original description where Cuba is not mentioned.

Seitz ignores the work of Godman and Salvin, places *tatila* as the Cuban subspecies and resurrects "*cœrulea*" with a respelling for the continental subspecies, creating much confusion.

From the facts, the name *tatila* applies to a Central American butterfly as is shown by Herrich-Schäffer's text and figures.

Specimens from Florida, Cuba and Jamaica and Hispaniola differ from Central American specimens in having the white spots of the forewing consistently smaller and in not having the discal

row of black spots on the underside of the hindwing finely pupiled with white. For these the name *tatilista* Kaye (1926: 473) seems available. There is no apparent basis for separating the Floridian or the several Antillean populations from each other for in any one area these butterflies show a great range of individual variation in any series of a dozen or more specimens which may be matched by like variation from another place.

Dr. Avinoff has examined the specimens in the Carnegie Museum collection and advises: ". . . the race *tatilista* of Jamaica is identical with the specimens of Florida . . . *tatilista* has not been found in recent years on Jamaica. Our very few specimens came from a collection made about half a century ago." Kaye's type came from Raetown, Jamaica, June 30, 1898 (C. B. Taylor). Dr. Avinoff says further: "The Central American specimens we have from Honduras, Guatemala and other localities are the true *tatila* with the white pupils on the reverse."

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PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Meeting of January 6, 1942

The annual meeting of the New York Entomological Society was held on January 6, 1942, in the American Museum of Natural History; Vice-President Weiss in the chair, with seventeen members and visitors present.

The following officers were elected for the year 1942

President	Harry B. Weiss
Vice-President	Wm. P. Comstock
Secretary	Annette L. Bacon
Treasurer	Dr. H. T. Spieth
Librarian	Leonard J. Sanford
Curator	Dr. W. J. Gertsch

Executive Committee
William T. Davis
Dr. William Proctor
Dr. Albert Hartzell
F. A. Soraci
Dr. A. B. Klots

Publication Committee
Harry B. Weiss
Ernest L. Bell
Herbert F. Schwarz
Edwin W. Teale

Delegate to the New York Academy of Sciences
William T. Davis

Mr. Albert Zerkowitz, 127 West 79th Street, New York City, was proposed for membership by Mr. Comstock.

Mr. Teale told of visiting Dr. L. O. Howard in Washington recently and that Dr. Howard sent his regards to the Society. Dr. Howard is an honorary member of the Society.

Mr. Davis showed a box of cicadas collected in southern California by Dr. and Mrs. Knull of Ohio, and told us about some of the unusual species represented in their collection.

Meeting of January 20, 1942

President Weiss in the chair, 138 visitors and members present.

Because of the large number of visitors present, all business was postponed until the next meeting.

Dr. A. L. Melander showed his colored motion pictures taken during the summer of 1941 in the Great Smokies of Tennessee and in the Adirondacks.

Meeting of February 3, 1942

President Weiss in the chair, 24 members and visitors present.

President Weiss appointed the following committees:

Program: Mr. Wm. P. Comstock, Mr. George G. Becker, Dr. Harold Hagan.
Field: Dr. A. B. Klots, Mr. A. S. Nicolay, Mr. F. S. Blanton.
Auditing: Dr. William Moore, Dr. W. J. Gertsch, Mr. M. H. Sartor.

Mr. Albert Zerkowitz was elected to membership.

Mr. A. T. Gaul, the speaker of the evening, told about his recent observations on hornets.

MEETING OF FEBRUARY 17, 1942

President Weiss in the chair, 30 members and visitors present.

President Weiss appointed a Fiftieth Anniversary Committee consisting of Mr. Teale and Miss Bacon, to make plans for an Anniversary meeting in the fall.

Mr. John D. Sherman, Jr., spoke about Entomological Literature and showed some very rare as well as some interesting books.

MEETING OF MARCH 3, 1942

President Weiss in the chair, 30 members and visitors present.

Dr. D. L. Collins told about his western trip last year to the various state universities and experiment stations at which entomological problems were being studied, especially in Idaho and California.

MEETING OF MARCH 17, 1942

President Weiss in the chair, 50 members and visitors present.

Mr. Louis Riehl was proposed for membership by Mr. Cazier.

Mrs. Kisliuk said Mr. Kisliuk was well on the road to recovery.

Mr. J. M. Singleton under the title "Some Phases of Port Inspection Problems" showed 900 feet of colored motion pictures accompanied by a general discussion on plant quarantine enforcement. An abstract is appended.

The subject was opened with a discussion of the plant quarantine station at Brownsville, Texas, and illustrations were thrown on the screen showing characteristic problems involved in preventing the entry of plant pests by airplane, rail, automobile and by foot bridge-passengers. Among the duties of plant quarantine inspectors on the Mexican Border is the fumigation of several thousand freight cars annually from Mexico. These are likely to be contaminated with cottonseed infested with the pink boll-worm, a destructive cotton pest. Experience has shown that such seeds are likely to be found anywhere inside or on the outside of freight cars. Hence the entire cars are fumigated. The freight car fumigation house at Laredo, Texas, was shown. This large fumigation plant accomodates 20 freight cars at a time. At San Diego, California, much of the inspectors' time is taken up in cooperation with the Navy whose large volume of shipping is conducted with deference to our plant quarantine regulations. Illustrations of the work at San Francisco showed the inspection of clipper planes. A large corps of uniformed plant quarantine inspectors was also shown handling the baggage of passengers from Hawaii. Inspection service is maintained at various ports along the Canadian Border and illustrations showed some of the problems involved as encountered at Blaine, Washington, and Detroit, Michigan. The airplane view of the water front of the port of New York gave one an idea of the scope of activities involved in preventing the entry of plant pests through several hundred miles of this water front. Mr. Singleton showed some of the

more exacting work being conducted at the Department's plant quarantine station at Hoboken.—GEORGE G. BECKER.

MEETING OF APRIL 7, 1942

Vice-President Comstock in the chair, 30 members and visitors present.

Mr. Louis Riehl of the Rockefeller Foundation Laboratory, 341 East 25th Street, New York City, was elected to membership.

Mr. Bell told of his trip to Mississippi in January and of his entomological collecting in the vicinity of Hattiesburg.

MEETING OF APRIL 21, 1942

President Weiss in the chair, 50 members and visitors present.

Since the meetings of the A.A.A.S. are to be held in New York next December, Dr. Ruckes presented a motion that a committee be appointed to cooperate with the program committees of the two Entomological Associations which will be meeting here. Motion approved.

Dr. Th. Dobzhansky spoke on "Species as They Appear to a Geneticist." An abstract is appended.

Races are genetically open systems which exchange, or are capable of exchanging, genes with each other. Species are closed systems which are prevented from exchanging genes by reproductive isolating mechanisms. The transition from race to species is gradual; reproductive isolation takes time to become established. Some forms are only racially, and others forms clearly specifically distinct. But there are intermediate steps in the process of evolutionary differentiation at which the distinction between races and species is a matter of taste. The above statements can be illustrated by examples from the genus *Drosophila,* in which evidence from diverse sources, morphological as well as experimental, is available. In the general systematic practice a decision on the race-species issue must, however, be reached on basis of purely morphological data, supplemented by distributional information. It is difficult or impossible to secure direct evidence on the presence or absence of reproductive isolation between the forms examined. Nevertheless, the methods of modern systematics furnish inferential evidence which is in most cases fairly satisfactory.—TH. DOBZHANSKY.

MEETING OF MAY 5, 1942

President Weiss in the chair, 26 members and visitors present.

It was moved and seconded that Mr. Olsen's invitation to have the picnic of the Society at his home on June 14 be accepted. Motion unanimously carried.

Mr. Bird gave some personal reminiscences of Mrs. Parsons.

Dr. Charles D. Michener spoke on the "History and Behavior of a Colony of Harvester Ants." An abstract is appended.

Observations on a colony of harvester ants (*Pogonomyrmex californicus*) in Pasadena, California, have shown that for three or four months during the winter the nest is continually closed and that during the remainder of the year it is closed every night. Outside activity goes on only during the warmer parts of the days. The actions of the ants are well correlated with temperature; they are sluggish at 70° F., exhibit maximum foraging activities with

temperatures at the surface of the ground between 90° and 115° F., and are driven into the nest except for very brief excursions by temperatures over 120° F. Swarming occurs more than once each season, during the late mornings of certain clear hot days in June and July. The introduced Argentine ant (*Iridomyrmex humilis*) is a serious pest of the *Pogonomyrmex*. Although the harvesters apparently perceive seeds, which are their chief food, through antennal sensillæ, it appears likely that they are guided in their foraging excursions, notably in finding their way back to the nest, largely by the use of their eyes.—CHARLES D. MICHENER.

MEETING OF MAY 19, 1942

Vice-President Comstock in the chair, 42 members and visitors present.

Mr. Edwin Way Teale spoke on "Recent Advances in Insect Photography," telling about some of the professional insect photographers, and the equipment and methods used by each. A number of his own pictures were displayed.

ANNETTE L. BACON, *Secretary*.

THE AMERICAN COMMISSION ON SCIENTIFIC NOMENCLATURE IN ENTOMOLOGY

The disturbed condition of the world during the last few years has interfered with the activities of the International Commission on Zoological Nomenclature and there is no prospect that this Commission will again function successfully for several years to come. Entomologists in the United States have felt that this situation should not be allowed entirely to stifle progress in the development of nomenclature and the clarification of nomenclatorial problems. At the meetings of the Entomological Society of America and the American Association of Economic Entomologists in San Francisco, in December, 1941, a plan was adopted which called for the establishment of an American Commission on Scientific Nomenclature in Entomology.

In accord with the terms of this plan, Mr. C. F. W. Muesebeck and Professor G. F. Ferris were appointed to organize the Commission. That organization has now been completed and the Commission is ready to function. It includes Prof. J. C. Bradley, of Cornell University; Mr. W. J. Brown and Mr. G. Stuart Walley, of the Division of Entomology of the Department of Agriculture of Canada; Prof. G. F. Ferris, of Stanford University; Prof. T. H. Hubbell, of the University of Florida; Prof. H. B. Hungerford, of the University of Kansas; Dr. E. G. Linsley, of the University of California; Prof. Clarence E. Mickel, of the University of Minnesota; Mr. C. F. W. Muesebeck and Mr. P. W. Oman, of the United States Bureau of Entomology and Plant Quarantine; Prof. A. G. Richards, Jr., of the University of Pennsylvania; Dr. Herbert H. Ross, of the State Natural History Survey of Illinois; Prof. C. W. Sabrosky, of the State Agricultural College of Michigan; Dr. R. L. Usinger, of the College of Agriculture of California. Prof. G. F. Ferris has been elected as Chairman.

The Commission will receive, consider and advise upon such nomenclatorial problems as are presented to it. All acts of the Commission will be in harmony with the International Rules of Zoological Nomenclature, although recommendations for the

clarification, extension and improvement of these rules may be made. The Commission will report to the two parent societies at their next annual meeting. Communications concerning matters within the province of the Commission may be addressed to any of its members.

The New York Entomological Society

Organized June 29, 1892—Incorporated June 7, 1893

Certificate of Incorporation expires June 7, 1943

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P. M., in the AMERICAN MUSEUM OF NATURAL HISTORY, 77th Street and Columbus Avenue.

Annual dues for Active Members, $3.00; including subscription to the Journal, $4.50.

Members of the Society will please remit their annual dues, payable in January, to the treasurer.

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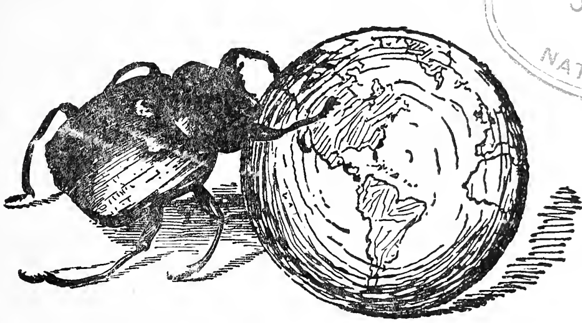

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NEW AND IMPERFECTLY KNOWN NEOTROPICAL POLYBIINÆ (HYMENOPTERA, VESPIDÆ)

By J. Bequaert

Museum of Comparative Zoölogy, Cambridge, Mass.

Group of *Polybia incerta*

Polybia incerta Ducke, *P. procellosa* Zavattari, and *P. æquatorialis* Zavattari are small, slender species, with a narrow, depressed thorax, the eyes with a few scattered, short hairs, and the humeral margin of the pronotum with a distinct, though low carina. *P. dubitata* Ducke belongs to the same group, but appears to be only a color form of *P. procellosa.* These species have been separated thus far mainly on color, but this varies, the several color forms being sometimes homeochromic. The three species I recognize are very close, the reliable structural differences I was able to discover, being mentioned in the key. The drawings may help to appreciate them. The males are unknown.

1. First abdominal segment long and slender, the tergite nearly three times as long as wide at apex, seen from above. Thorax less than twice as long as wide, seen from above; pro-mesonotal suture nearly semi-circular; upper part of propodeum without median groove. Upper part of outer orbits and vertex separated from occiput by a fine carina .... *P. æquatorialis.*
   First abdominal segment shorter, the tergite about two and a half times as long as wide at apex, seen from above. Propodeum with a shallow groove throughout. Vertex not separated from occiput by a carina ...... 2.
2. Thorax moderately lengthened, less than twice as long as wide, seen from above; pro-mesonotal suture nearly semi-circular .... *P. procellosa.*
   Thorax very long, about twice as long as wide, seen from above; pro-mesonotal suture decidedly semi-elliptical .... *P. incerta.*

Polybia æquatorialis Zavattari (1906) (Fig. 1 D)

P. æquatorialis is the best defined species of the group. It has a very short, though distinct oculo-malar space, lacking in the others. It varies from black and testaceous to completely black, with a few paler markings.

1. Typical form.—Zavattari described this as black, with the first two abdominal tergites and most of the sternites ferruginous or testaceous, margined with yellow, the legs yellowish-testaceous. Thorax with hind margin of pronotum, two dots on postscutellum, a line on mesopleura, and two spots on propodeum, yellow. Wings gray with yellowish tinge; tegulæ yellow. The type locality is Pun, in eastern Ecuador, a locality not found on any of my maps.

Specimens from COLOMBIA (Almaguer, 10,500 ft., Dept. Cauca; San Miguel, Dept. Cundinamarca) agree well with this, but in some the anterior margin of the postscutellum is completely yellow. Many others from ECUADOR (Baños, Tungurahua, 1000 to 1900 m.) differ only in having more extensive yellow markings on the thorax.

Ducke records this species from Bogotá, Colombia (2650 m.); but this is certainly an erroneous locality. No social wasp of the subfamily Polybiinæ has been actually taken at Bogotá or in the near vicinity; the nearest locality known to me for any species is Fusugasuga, at a much lower altitude.

2. *P. æquatorialis* var. (or subsp.) **nigricans,** new.

FEMALE OR WORKER.—Body black, without ferruginous or testaceous. Broad apical margin of clypeus, a streak at base of mandible, a spot in lower corner of frons, under side of scape, hind margin of pronotum, sometimes streaks or spots on scutellum and postscutellum, large spots on propodeum, a streak on mesopleura, tegulæ, and apical margins of most tergites and sternites, yellow. Legs testaceous-yellow. Wings grayish, with slight yellowish tinge, more infuscate in radial cell.

ECUADOR: Baños, Tungurahua, 1600 to 1900 m., female holotype and paratypes (W. Clarke-MacIntyre). Types at Mus. Comp. Zoöl., Cambridge, Mass.

3. *P. æquatorialis* var. (or subsp.) **tristis,** new.

FEMALE OR WORKER.—Black, the pale yellow markings reduced to narrow hind margin of pronotum, a dot on the base of the mandible, and narrow apical margins of tergite 1 and some of the sternites. Legs almost com-

pletely black. Tegulæ black. Wings strongly smoky, darker anteriorly and in radial cell, without yellowish tinge.

PANAMA: El Volcan, Chiriqui, 10,000 ft. female holotype and paratypes (D. W. Bishop). Types at Mus. Comp. Zoöl., Cambridge, Mass.

Polybia procellosa Zavattari (1906) (Fig. 1 E–F)

1. Typical form.—As originally described, this is mostly ferruginous-brown, with the head, disk of mesonotum and scutellum black, and with very few yellowish or whitish markings; legs testaceous; wings tinged with yellowish. The type locality was San José, 1800 m., in eastern Ecuador.

I refer to this a series of specimens from Jutan Yacu, Rio Napo Watershed, 700 m., ECUADOR. Some of them agree well with the description, but others have the body more infuscated or have more yellow markings.

2. *P. procellosa* var. *dubitata* Ducke (1910). Originally described as a species, from the Amazon Basin, Brasil (Belem do Pará; Obidos; Tabatinga). I recognize it in a series of specimens from Kurupung, BRITISH GUIANA; and Satipo, 600 m., eastern PERU. These are black with few or very few yellowish or whitish markings; legs and tegulæ black; wings grayish without yellowish tinge.

Although these specimens differ conspicuously in color, I am unable to find a reliable structural difference between them and typical *procellosa*. Ducke mentions no structural characters to separate *procellosa* from *dubitata*.

Polybia incerta Ducke (1907)

1. Typical form.—*P. incerta* was described as ferruginous-testaceous, with parts of head, mesonotum and hind part of abdomen more brownish, the apical margins of the segments discolored; legs testaceous-yellow. Wings hyaline, with testaceous veins.

A series of specimens taken by Dr. W. Weyrauch from a nest at Satipo, 600 m., PERU, agree well with this, except that there are a few yellowish markings blending more or less with the testaceous ground-color. The tegulæ are yellow.

2. *P. incerta* var. (or subsp.) **weyrauchi,** new (Fig. 1 A–C).

QUEEN AND WORKER.—Head moderately swollen, slightly wider than thorax; seen in front, slightly wider than high; seen from above, slightly over two and a half times as wide as long; occipital margin with a shallow inward curve. Outer orbits (genæ) and vertex not separated from occiput by a carina (sometimes a trace of a carina on middle of orbit); occipital face of head with a fine curved ridge, preceded by a groove, running above the occipital foramen and curving downward and outward at the sides where it

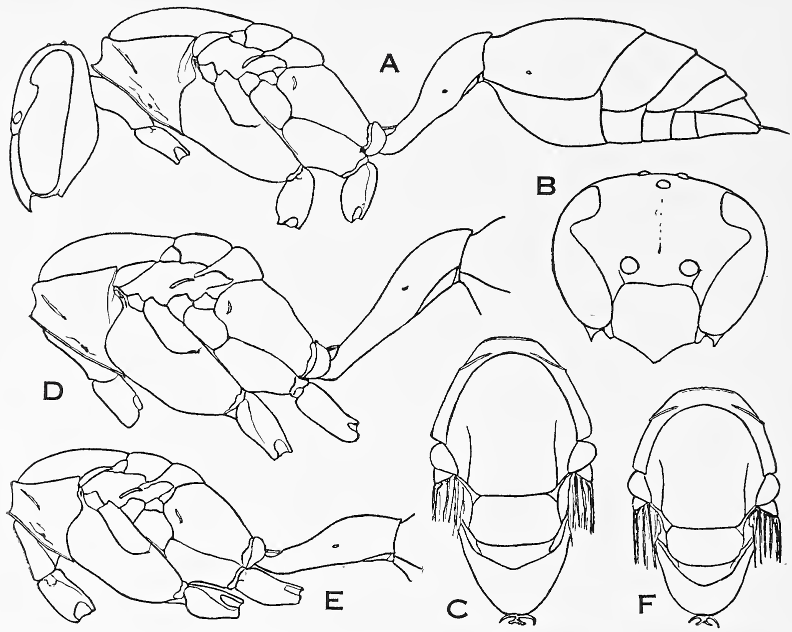


FIG. 1. A–C, *Polybia incerta* var. *weyrauchi* J. Bequaert, female holotype: A, body in profile; B, head in front view; C, thorax from above. D, *Polybia æquatorialis* Zavattari, female: thorax and tergite 1 in profile. E–F, *Polybia procellosa* Zavattari, female: E, thorax and tergite 1 in profile; F, thorax from above.

stops near the edge at lower third of outer orbit. Oculo-malar space practically absent; mandibular condyle almost touching eye. Outer orbit well developed, in profile nearly as wide as eye and somewhat swollen in upper corner. Inner orbits much farther apart on vertex than at clypeus. Ocelli large, close together, in an almost equilateral triangle; posterior ocelli three times as far from eyes as from each other. Antennæ about twice as far apart as from eyes; interantennal area slightly and evenly convex, with an upper concavity bearing a deep elongate pit; upper half of frons slightly

swollen on either side of anterior ocellus. Clypeus about as wide as long, pentagonal with upper side longest and lateral sides slightly longer than lower sides; contiguous with eyes over about two-thirds of sides; anterior margin moderately produced, broadly rounded off at apex. Mandibles about two and a half times as long as wide at base, with subparallel sides; outer surface slightly convex over apical half, flattened over basal half; cutting edge slightly oblique, with four teeth, the upper one very short and blunt, the three lower ones acute and subequal. Antenna: scape slender, slightly curved, about six times as long as thick (seen in profile), about as long as the following four segments together; third segment two and one-third times as long as wide at apex, as long as fourth and fifth together; fourth longer than wide; fifth and sixth about as long as wide; seventh to eleventh distinctly wider than long; twelfth longer than wide at base; flagellum slightly and very gradually swollen apicad of fourth segment. Thorax unusually long and depressed, nearly twice as long as high in profile; seen from above, elongate-elliptical, much narrowed anteriorly; dorsal areas of pronotum extremely narrowed; humeral margin with a strongly curved carina, distinct at the sides where it ends without projecting angles, effaced medially; pleura as usual in *Polybia;* mesonotum much longer than wide, flattened over posterior half; pro-mesonotal suture semi-elliptical; scutellum about one and a half times as wide as long, flat; postscutellum longer than usual; propodeum much narrowed posteriorly, with a distinct, narrow, groove-like concavity. Abdomen similar to that of *Polybia occidentalis.* First segment much narrowed, seen from above with the basal half narrower, ribbon-shaped, rather suddenly widened into the slightly swollen and gradually expanding apical half; spiracles barely projecting, placed about midway. Legs slender; coxæ long, flattened; mid tibiæ with two spurs; claws symmetrical. Wings lengthened; venation as usual.

Dull; body densely covered with microscopic, granular or coriaceous punctures, except over lower half of clypeus and parts of propodeum, which are shiny; no larger punctures visible with a hand-lens, except a few over apical half of clypeus, mandibles and lower portion of outer orbits. Erect pubescence very short, grayish, somewhat longer on propodeum; sides of thorax and propodeum with a slight silvery sheen. Eyes with a few, scattered, short hairs.

Black. A dot at base of mandible, middle of hind margin of pronotum, narrow apical margins of tergite 1 or of some of the next tergites also, and broader apical margins of sternites 2 to 5, whitish. Tibial spurs and claws testaceous. Tegulæ black. Wings very slightly smoky, somewhat darker anteriorly; radial cell and adjoining area of third and fourth cubital cells infuscate and somewhat purplish. Veins and stigma blackish-brown.

Length (h. + th. + t. 1 + 2): 7.8 to 8.5 mm.; of fore wing, 8 to 9 mm.

PERU: Oxapampa, female holotype and many paratypes from a nest, at 1800 m. altitude; also 2 female paratypes, flying at 1200 m. (W. Weyrauch). I have also two female paratypes from

an old collection labelled merely "Peru." Holotype and paratypes at Mus. Comp. Zoöl., Cambridge, Mass.; paratypes at U. S. Nat. Mus., Amer. Mus. Nat. Hist., Ac. Nat. Sci. Phila., etc.

The nest will be described by Dr. Weyrauch.

Although the color is very distinctive, I was unable to find structural differences between this new form and *P. incerta,* so that I am forced to regard it as a melanistic race of that species. I have, however, described it in detail for the convenience of future workers.

Polybia nigratella R. du Buysson (1905)

This was originally described, as *Polybia occidentalis* var. *nigratella,* from Oaxaca, Mexico. Ducke pointed out that it could not be a form of *Polybia occidentalis* and suggested that it might have been his *P. dubitata.* I believe, however, that I have recognized it in a series of females or workers which I took at Chitzen Itza, YUCATAN, from one nest. These look superficially like unusually sturdy *P. occidentalis;* but the humeral margin of the pronotum bears a distinct, though low carina on the sides, the vertex is not separated by a carina from the occiput, and the sides of the thorax show distinct small punctations scattered in the dense, microscopic sculpture. These specimens also resemble *P. procellosa* var. *dubitata,* which, however, differs in the more slender thorax, flattened above, and the lack of distinct larger punctures on mesopleura. The eyes of *P. nigratella* bear a few short, scattered hairs.

Polybia bifasciata H. de Saussure (1854)

Although *P. bifasciata* is one of the rarer species of *Polybia,* it occurs in a number of color forms which appear worthy of distinct names. The following key will separate them.

1. Wings strongly tinged with amber-yellow; veins and stigma pale russet; radial cell and tip of wing mostly infuscate .... 2.
   Wings nearly hyaline, without yellowish tinge; veins and stigma blackish-brown; radial cell and tip of wing mostly infuscate .... 3.
2. Abdomen extensively fulvous-orange, without distinct apical pale yellow fasciæ. Thorax spotted with orange-yellow .... var. *restrepoensis.*
   Body black, without fulvous-orange. Abdominal segment with pale yellow apical fasciæ. Thorax with a very few or no pale markings .... var. *mellipennis.*

3. Base of second tergite with pale yellowish spots on the sides; apical margins of most tergites and sternites and markings of thorax pale yellow .... var. *cordata*.
   Base of second tergite black, without yellow or brownish markings .... 4.
4. Tergites and sternites 4 to 6 mostly orange-yellow. Remainder of abdomen and thorax black .... var. *xanthopyga*.
   Apical segments not mostly orange-yellow .... 5.
5. First 3 to 5 abdominal tergites and some of the sternites with yellowish hind margins. Thorax with several yellowish markings. var. *quadricincta*.
   Only first or first and second tergites and some of the sternites with yellowish-white hind margins, or abdomen entirely black .... 6.
6. Thorax and abdomen entirely or almost entirely black; at most a very narrow apical whitish margin on first tergite and on some of the sternites .... var. *heydeniana*.
   Thorax and abdomen more distinctly marked with yellowish; both first and second tergites and some of the sternites with an apical fascia. typical *bifasciata*.

1. Typical form: *Polybia bifasciata* H. de Saussure, 1854, Et. Fam. Vesp., II, p. 172, Pl. XXII, fig. 3 (♀). Originally described from Brasil. I have seen it from BRITISH GUIANA (Kartabo) and eastern PERU (San Ramon, Valle Chanchamayo, 800 m.; Tingo Maria, Rio Huallaga, 700 m.).

2. *P. bifasciata* var. *heydeniana* de Saussure: *Polybia heydeniana* H. de Saussure, 1863, Mém. Soc. Phys. Hist. Nat. Genève, XVII, pt. 1, p. 241 (♀). Originally described from Brasil, without more definite locality. I have seen it from BRASIL (São Paulo, Capital), PERU (Iquitos; Oxapampa, 1100 m.; Tingo Maria, Rio Huallaga, 700 m.), COLOMBIA (Muzo, Dept. Boyacá, 900 m.), and PANAMA (Barro Colorado Id.).

Polybia theresiana W. A. Schulz (1904, Berlin. Ent. Zeitschr., XLVIII, (1903), pt. 4, p. 257; ♀; between Bodega and Honda, Rio Magdalena, Colombia), I regard as a form of *P. bifasciata* and identical with the var. *heydeniana*.

Transitional specimens connect typical *bifasciata* and var. *heydeniana*.

3. *P. bifasciata* var. *quadricincta* de Saussure: *Polybia quadricincta* H. de Saussure, 1854, Et. Fam. Vesp., II, p. 173 (♀). Originally described from "America," it is the most common form of the species. I have seen it from BRITISH GUIANA (Bartica; Kartabo; source of the Essequibo River; Wanaina, N.W.

District), FRENCH GUIANA (Saint-Jean), TRINIDAD, VENEZUELA (Mt. Duida), COLOMBIA (Restrepo), eastern PERU (San Ramon, Valle Chanchamayo, 800 m.), and BOLIVIA (San Fernando Rapids; Huachi, Rio Beni; Rurrenabaque, Rio Beni).

4. *P. bifasciata* var. *cordata* F. Smith: *Polybia cordata* F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 129 (♀). Described from the Amazon River, Brasil. I have not seen it. According to the description it has basal pale spots on the second tergite, connected with the lateral extensions of the apical fascia; while the wings are hyaline with a dark fuscous spot in the costal and radial cells.

5. *P. bifasciata* var. (or subsp.) **xanthopyga**, new.

FEMALE OR WORKER.—Head black; mandibles with a yellowish basal dot. Thorax black. Abdomen black; tergites 4 to 6 and sternites 3 to 6 almost entirely orange-yellow. Legs and antennæ black. Wings as in typical *P. bifasciata.*

COLOMBIA: Villavicencio, Int. del Meta, 450 m., female holotype (J. Bequaert).—PERU: Oxapampa, female paratype (W. Weyrauch).—Types at Mus. Comp. Zoöl., Cambridge, Mass.

6. *P. bifasciata* var. (or subsp.) **restrepoensis**, new.

FEMALE OR WORKER.—Head black; a yellowish basal dot on mandibles. Thorax black, with the following yellowish markings; humeral and hind margins of pronotum; a vertical streak in upper inner corner of mesepisternum; spots on tegulæ and extreme anterior corners of scutellum; anterior margin of postscutellum; two spots on propodeum. Legs black. Abdomen black and orange-yellow; in the holotype from Colombia the orange covers the hind margins of the tergites and sternites and most of the second tergite (except for an irregular transverse black area in posterior half); in some paratypes of Peru, the abdomen is almost completely orange (except for the base of the first and the entire sixth tergite); all transitions occur between these two extremes; in a paratype from Colombia the second tergite is much more extensively black than usual. Wings mostly subhyaline, with a very strong honey-yellow tinge, particularly toward the costa; veins and stigma mostly russet-yellow; radial cell and apex of wing infuscate, violaceous.

MALE.—Head and thorax more profusely marked with yellow, particularly on the clypeus and under side of scape. Fore coxæ mostly yellow. Abdomen mostly orange-yellow. Wings as in female.

COLOMBIA: Restrepo, Int. del Meta, 500 m., female holotype and female paratype (J. Bequaert).—PERU: San Ramon, Valle Chanchamayo, 900 m., many female paratypes, male allotype and six male paratypes, all from one nest; and one female paratype caught drinking at edge of stream (W. Weyrauch); Oxapampa,

1200 m., female paratypes from one nest (W. Weyrauch).—Types at Mus. Comp. Zoöl., Cambridge, Mass.

P. bifasciata var. *restrepoensis* is homeochromic with the typical color form of *Polybia rejecta* (Fabricius), from which it is readily told by the low humeral carina of the pronotum, the shorter thorax and the much shorter first abdominal segment.

The specimens from San Ramon and Oxapampa were obtained from mixed colonies. Of the 97 wasps sent from the San Ramon nest, 75 females and 7 males are of the var. *restrepoensis,* 13 females and 2 males of the var. *mellipennis.* Only four females from the Oxapampa nest were received, 2 of them var. *restrepoensis,* 1 var. *heydeniana* and 1 var. *xanthopyga.* In either case transitional specimens were absent. A possible explanation is that these colonies were started each by several fertile and impregnated queens belonging to different color forms, their offspring remaining distinct. No doubt the workers or females of all forms shared in the maintenance and feeding of the colony. Yet this case might illustrate one of the ways in which social parasitism originated.

7. *P. bifasciata* var. (or subsp.) **mellipennis,** new.

Female of Worker.—Head black. Thorax black, with at most hind margin of pronotum narrowly whitish-yellow. Legs black. Abdomen black; apical margins of first to fifth tergites and second to fifth sternites narrowly whitish-yellow. Wings as in var. *restrepoensis,* extensively suffused with honey-yellow. Some specimens lack yellowish margins on some of the tergites.

Male.—Differs from the female only in having the underside of scape and a spot on each lower corner of frons yellowish; the clypeus is black.

Peru: San Ramon, Valle Chanchamayo, 900 m., female holotype, male allotype and several paratypes of both sexes, taken from one nest, together with many specimens of both sexes of the var. *restrepoensis* (W. Weyrauch); also a few at flowers of coffee trees. Types at Mus. of Comp. Zoöl., Cambridge, Mass.

This form combines the yellowish wings of var. *restrepoensis* with the body markings of var. *quadricincta,* although the thorax is much blacker than in the latter.

Brachygastra bilineolata Spinola, 1841[1]

The following key separates the color forms of this species.

1. Second abdominal tergite with only the apical margin yellow. Mesonotum

[1] The older generic name *Brachygastra* is here used for *Nectarina.*

with short yellow longitudinal stripes, or with a pair of yellow spots posteriorly, or entirely black. Wings with a honey-yellow tinge, most of the veins testaceous ....typical *bilineolata.*

Second abdominal tergite with a broad or narrow discal yellow band in addition to the apical fascia, or mostly yellow. Mesonotum always with two long yellow stripes .... 2.

2\. Second abdominal tergite mostly yellow, except for the black base and a more or less defined transverse black discal blotch or irregular line. Wings with a honey-yellow tinge ....var. *surinamensis.*

Second abdominal tergite with two separated transverse yellow stripes of about equal width, one apical, the other discal .... 3.

3\. Thorax very extensively yellow, the propodeum mostly of that color. Wings nearly hyaline, not tinged with yellow ....var. *propodealis.*

Thorax less extensively yellow, the propodeum black .... 4.

4\. Wings extensively tinged with honey-yellow. Veins and stigma mostly pale ....var. *antillarum.*

Wings nearly hyaline, slightly grayish, not suffused with yellow; veins and stigma blackish ....var. *smithii.*

1\. Typical form: *Brachygastra bilineolata* Spinola, 1841, Ann. Soc. Ent. France, X, p. 126 (♀; Cayenne, French Guiana). According to the original description, the second tergite had only the apical margin yellow, while the mesonotum had two longitudinal yellow lines. H. de Saussure saw Spinola's types and his description and figure (1854, Et. Fam. Vesp., II, p. 228, Pl. XXXIV, fig. 2) agree with this. I am unable to separate, even as a variety, *Nectarinia möbiana* H. de Saussure, 1867, Reise der Novara, Zool., II, pt. 1, Hym., p. 22 (♀; Surinam). This is described as lacking the discal yellow cross-band on tergite 2, but having in addition an entirely black mesonotum. Of the specimens without discal band on tergite 2 before me, some have the mesonotum black, others have a pair of triangular yellow spots before the scutellum, and some have short yellow lines (or traces of them) over part of the mesonotum. *Brachygastra dorso-lineata* Spinola (1841, *Op. cit.*, p. 123) was a clerical error for "*bilineolata,*" hence also a synonym of the typical form.

I have seen the typical form from BRITISH GUIANA (Georgetown; Demerara), VENEZUELA (Guanta), BRASIL (Sa. Catharina; Chapada), COLOMBIA (Villavicencio), and COSTA RICA (San José).

2\. *B. bilineolata* var. *antillarum* (Provancher): *Odynerus antillarum* Provancher, 1888, Additions Faune Canada, Hymén.,

p. 420 (♀; Trinidad). Provancher's description leaves no doubt as to the identity of his wasp. He mentions the smooth clypeus, rounded off anteriorly, the peculiar shape of the first and second abdominal segments and of the propodeum, the puncturation of the thorax and the characteristic color pattern. The two longitudinal streaks on the mesonotum, the discal fascia of the second segment and the wings yellowish near the costa mark it as the most common form of *N. bilineolata,* for which no other published name is available. Furthermore, it is common in Trinidad, and the only form of the species I have seen from there.

The var. *antillarum* is found in BRITISH GUIANA (Rupununi River), DUTCH GUIANA (Paramaribo), TRINIDAD (Mayaro Bay), BRASIL (Vista Alegre on the Rio Branco), eastern PERU (Iquitos; Lower Rio Napo), and the REPUBLIC OF HONDURAS (Tegucigalpa).

3. *B. bilineolata* var. *smithii* (de Saussure): *Nectarinia smithii* H. de Saussure, 1854, Et. Fam. Vesp., II, p. 229, Pl. XXXI, fig. 8 (♀). Originally described from Santarem, Brasil. I have seen it from COLOMBIA (Rio Frio, Dept. Magdalena; Puerto Olaya, Dept. Santander; Muzo, Dept. Boyacá), FRENCH GUIANA (Nouveau-Chantier), and BRASIL (Carvoeiro, junction of Rio Negro and Rio Branco; Flores near Manaos). It is somewhat less silky than the var. *antillarum. Caba bilineolata* var. *fasciata* R. v. Ihering (1904, Rev. Mus. Paulista, VI, pp. 106 and 112), described from Surinam and Brasil (Rio Juruá), is a synonym of *smithii.*

4. *B. bilineolata* var. (or subsp.) **propodealis**, new.

FEMALE OR WORKER.—Head black, with most of clypeus (except a median brown spot), very broad outer and inner orbits connected with a broad cross-band on vertex, and a large interantennal spot on frons, yellow. Thorax black, with dorsal face of pronotum, two broad longitudinal stripes on mesonotum (fused behind), scutellum (except for a transverse black streak), postscutellum, most of concavity and lateral ridges of propodeum, and a streak in upper half of mesepisternum, yellow. Legs black, with under side of fore coxæ and more or less of under side of all femora, yellow. Abdomen black, with broad apical margins of all tergites and sternites, a broad transverse fascia on disk of second tergite (not connected with apical margin) and large discal spots on sides of second sternite, yellow. Wings subhyaline, without yellowish tinge; veins and stigma blackish-brown.

PERU: Middle Rio Marañon, female holotype. Mus. of Comp. Zoöl., Cambridge, Mass.

5. *B. bilineolata* var. (or subsp.) **surinamensis**, new.

FEMALE OR WORKER.—Head and thorax black, with many yellow markings, as in var. *antillarum;* concavity of propodeum black. Legs black. Abdomen black, with broad yellow apical margins on all tergites and sternites; second tergite mostly yellow, except for the black base and sometimes for a narrow or ill-defined discal blackish-brown blotch or cross-streak; but the yellow of the disk is always connected with the apical margin, at least at the sides. Wings as in var. *antillarum,* extensively tinged with honey-yellow; most of veins and stigma testaceous.

DUTCH GUIANA (or Surinam), without more definite locality, female holotype and paratypes. Mus. of Comp. Zoöl., Cambridge, Mass.

Brachygastra scutellaris (Fabricius, 1804)

The color forms of this species may be separated as follows.

1. Scutellum black; postscutellum black with an anterior pale cross-band (sometimes almost lacking) .... 2.
   Scutellum and postscutellum mostly or entirely yellow .... 3.
2. Pale markings of abdomen reduced to narrow whitish apical margins on second and third sternites. Wings extensively smoky anteriorly and near base .... var. *colombiensis.*
   Pale apical (whitish) margins on most sternites and some tergites. Wings slightly grayish or somewhat smoky anteriorly and toward base. var. *myersi*
3. Pale color almost restricted to scutellum and postscutellum; usually only some sternites and first tergite of abdomen with narrow pale apical margins. Wing with costal and subcostal cells conspicuously smoky. var. *gribodoi.*
   Pale color much more extensive on thorax and abdomen .... 4.
4. Second abdominal tergite mostly orange-yellow or ferruginous. Thorax extensively marked with yellow; mesonotum usually with spots or stripes .... var. *rufiventris.*
   Second abdominal tergite with only an apical yellow margin .... 5.
5. Yellow of pronotum almost absent or restricted to the narrow, often incomplete humeral margin. Apical margins of abdominal segments narrow, whitish-yellow .... typical *scutellaris.*
   Yellow extending over most of pronotum. Apical margins of abdominal segments wide, orange-yellow .... var. *annectens.*

1. Typical form: *Vespa scutellaris* Fabricius, 1804, Syst. Piezat., p. 265. Described from "South America" as follows: "V. atra, scutello flavo, abdominis segmentis margine flavis. Statura parva *V. nidulans.* Caput cum antennis atrum: fascia sub antennis argenteo villosa. Thorax punctatus ater scutello

fulvo, immaculato. Abdomen segmentorum marginibus flavis: segmento secundo maximo. Alæ albæ, costa nigra. Pedes atri.'' This description only fits the typical form as characterized in my key. It is true that only the scutellum is said to be yellow, whereas all specimens I have seen have the postscutellum also at least partly yellow; but on the insect seen from above the postscutellum is completely hidden from view. Of *Brachygastra scutellata* Spinola (1851, Mem. Ac. Sci. Torino, Sci. Fis. Mat., (2) XIII, p. 74), the main form and var. A, described from ''Brasil,'' were typical *scutellaris;* but the var. B, from Para, was var. *rufiventris* de Saussure.

Typical *B. scutellaris* is the most common form of the species. I have seen it from PANAMA (Cabima), BRITISH GUIANA (Forest Settlement, Mazaruni River; Kartabo; junction of Mazaruni and Essequibo Rivers), FRENCH GUIANA (Nouveau Chantier; Saint-Jean-du-Maroni), and BOLIVIA (Huachi, Rio Beni; Blancaflor, Rio Beni; near mouth of Rio Mapiri). It is also reported from Brasil (as far south as São Paulo), eastern Peru (Iquitos; Marcapata) and Colombia.

2. *B. scutellaris* var. (or subsp.) **annectens**, new.

FEMALE OR WORKER.—Head black, with broad apical margin of clypeus, a spot in each lower corner of frons, an elongate spot on upper outer orbit (sometimes lacking), and two oblique lines on vertex (more or less connected), yellow. Thorax black, with most of dorsal face of pronotum, tegulæ, posttegulæ, scutellum and postscutellum yellow. Legs black. Abdomen black, with broad apical yellow margins on tergites and sternites 2 to 5 and a narrow one on tergite 1. Wings nearly hyaline, somewhat infuscated toward costal margin.

COLOMBIA: Muzo, Dept. Boyacá, 900 m., female holotype and paratype (J. Bequaert). Types at Mus. Comp. Zoöl., Cambridge, Mass.

3. *B. scutellaris* var. *rufiventris* de Saussure: *Nectarinia rufiventris* H. de Saussure, 1854, Et. Fam. Vesp., II, p. 226 (♀). Originally described from Pará, Brasil. I have seen it from COLOMBIA (Muzo, Dept. Boyacá, some at flowers of *Mikania scandens*). The orange-fulvous second tergite is sometimes blotched with black. R. du Buysson reports it from French Guiana (Cayenne).

4. *B. scutellaris* var. *gribodoi* R. du Buysson: *Nectarina scu-*

tellata var. *gribodoi* R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIV, p. 549 (♀ ☿). This is *Brachygastra scutellaris* Perty, 1833, Delectus Anim. Articul. Brasil., p. 146 ("tota nigra, alis fuliginosis, scutello flavo"). Recorded thus far from eastern Peru (Pevas; Iquitos). I have seen it from PERU (Tingo Maria, Rio Huallaga, 700 m.) and COLOMBIA (Restrepo, Int. del Meta, 500 m.).

5. *B. scutellaris* var. (or subsp.) **myersi**, new.

FEMALE OR WORKER.—Head black, with a yellowish spot in each lower corner of frons. Thorax black, with anterior (or upper) half or less of postscutellum pale yellow. Legs black. Abdomen black, with narrow or incomplete whitish apical margins on all or some tergites and sternites. Wings subhyaline, more or less grayish or rather extensively infuscated anteriorly and toward base.

BRITISH GUIANA: Mt. Roraima, female holotype and 5 female paratypes (J. G. Myers).—BOLIVIA: Cavinas, Rio Beni, female paratype (W. M. Mann). Holotype and paratypes at Mus. of Comp. Zoöl., Cambridge, Mass.; paratype from Bolivia at U. S. Nat. Mus.

6. *B. scutellaris* var. (or subsp.) **colombiensis**, new.

FEMALE OR WORKER.—Black, except for a small whitish spot in each lower corner of frons, narrow anterior (or upper) yellowish margin of postscutellum (sometimes barely indicated), and very narrow whitish apical margins on sternites 2 and 3. Wings smoky, strongly infuscated over costal half and near base.

COLOMBIA: Restrepo, Int. del Meta, 500 m., female holotype and 4 female paratypes (J. Bequaert). Types at Mus. Comp. Zoöl., Cambridge, Mass.

This is evidently the variety with black scutellum and postscutellum, from Colombia, mentioned by Ducke (1910, Ann. Mus. Nat. Hungarici, VIII, p. 479).

NOTES ON ECUADORIAN BUTTERFLIES, V

BY F. MARTIN BROWN

CITHÆRIAS, HÆTERA AND PSEUDOHÆTERA N. G. (SATYRIDÆ)

The species that compose these genera are usually met with in Ecuador in the cool dark of the tropical and subtropical jungle. Their flight is close to the ground and slow, but erratic in its course. They have the tantalizing habit of lazily drifting down the trail a few feet in front of you only to fade into the underbrush at the sweep of a net. Their transparent forewings, the delicate colors and the bold ocelli on the outer margin of the hindwing combine to present the eerie impression of disembodied eyespots gayly wandering through the forest. Although *P. hypæsia* Hewitson is much the most common species in our collections it is probably no more common than most of the species in nature. It seemed to show more preference for open glades and broad trails than did the others and therefore more frequently fell prey to the collector's net. Weymer says of the genus *Cithædias* (as *Callitæra,* Seitz' V, p. 174) that it is particularly fond of the early morning hours for flight. I cannot remember that they were any less frequent at midday or in the afternoon. Their habits may be different along the Atlantic seaboard where the midday and afternoon is so much warmer than in the upper Amazon forest and Andean foothills.

KEY TO THE NEOTROPICAL TRANSPARENT WINGED *Satyridæ*

1a. M_3 and Cu_1 of the hindwing connate 2
b. These veins with clearly separate origins .... *Cithærias* 5
2a. Outline of outer margin of hindwing angular .... *Hætera* 3
b. Outline of outer margin of hindwing not angular
Pseudohætera hypæsia
3a. A strong yellow flush on the outer half of the hindwing
H. piera & ff. 16
b. This flush absent 4
4a. Outer margin of hindwing red or reddish at least in the angle
H. macleannania & ff. 19
b. No red on the hindwing .... *H. diaphana*
5a. Hindwing with pink or red scaling, occasionally red-lilac; no blue or deep violet scales 6

b. Hindwing principally blue or violet scaled, or brownish tan lacking any pink 10
6a. A distinct brownish or deeper pink submarginal line on hindwing 7
b. Hindwing with a broad brownish marginal band (see figure) *C. menander*
7a. Hindwing with three transverse lines, submarginal, limbal and discal: limbal line nearer the discal than submarginal on anal margin (see figure) .... *C. pireta*
b. The three lines about equidistant (see figure). Forewing with two brownish transverse lines 8
8a. Pink of the hindwing not entering the cell 9
b. Pink of the hindwing entering the cell .... *C. aurorina*
9a. Pink of the hindwing bold, often lilac-pink .... *C. aurora*
b. Pink of the hindwing weak, usually rosy pink .... *C. phantoma*
10a. Hindwing with blue or violet scaling 11
b. Hindwing lacking blue or violet scaling 15
11a. Three large pink spots surrounded by deep violet on the margin of the hindwing .... *C. pyropina*
b. Otherwise .... *C. philis* & ff. 12
12a. An ocellus or a pinkish white spot between Cu_1 and Cu_2 *C. p. esmeralda* & ff. 13
b. This ocellus or spot lacking .... *C. p. philis*
13a. A single ocellus posterior of the normal anterior ocellus *C. p. harpalyce*
b. Two ocelli or pinkish white spots flanking the Cu_2 14
14a. Two ocelli .... *C. p. esmeralda*
b. Two pinkish white spots .... *C. p. esmeralda* f. *bandusia*
15a. Transverse band of the hindwing connected with the margin by broad brown stripes on the veins .... *C. p. philis* f. ♀ *pellucida*
b. Transverse line of the hindwing not so connected .... *C. polita*
16a. ♂ anterior ocellus of hindwing lacking .... *H. piera* f. *unocellata*
♀ anterior ocellus the smaller .... *H. piera* f. *unocellata*
b. ♂ two ocelli, ♀ anterior ocellus the larger 17
17a. No red at margin of hindwing, transverse band obsolescent *H. p.* f. *negra*
b. Red at margin of hindwing 18
18a. Transverse bar over posterior ocellus only slightly basad, ♀ with little or no submarginal red .... *H. piera* f. *piera*
b. This bar markedly basad, ♀ with submarginal red extending to the transverse band .... *H. piera* f. *ecuadora*
19a. Transverse band obsolescent between M_3 & Cu_2 on the hindwing *H. m. macleannania*
b. This area of the band bold .... *H. m. laddeya* 20
20a. ♀ with normal red submarginal area on hindwing .... *H. m. laddeya*
b. ♀ lacking red submarginal area on hindwing *H. m. laddeya* f. ♀ *neglecta*

An examination of the male genitalia of these insects at once shows that there are four groups into which the aggregate may be divided on that basis. For two of these groups valid names are available, *Cithærias* and *Hætera.* Of the former genus *polita* is aberrant and of the latter *hypæsia.* In the following discussion these will be mentioned by the specific name. I will use *aurorina* as model for *Cithærias* and *piera* for *Hætera.*

VENATION: FOREWING. There are several variable factors on this wing. The dilated portion of the subcosta extends about 0.6 of the length of the cell in *piera* while in the other three it is much less. It is 0.4 for *aurorina* and *polita* and only 0.33 for *hypæsia.* The first and second radial branches are emitted before the end of the cell in all four. In *piera* and *polita* the R_2 is emitted about half way from R_1 to the end of the cell; in *piera* it is emitted about two-thirds of the distance from R_1 to the end of the cell while in *hypæsia* it is emitted only one-third the distance from R_1 to the end of the cell. The first branch of the median has its origin on the R_s just beyond the end of the cell in *aurorina* and *polita* and at the end of the cell in *piera* and *hypæsia.* There is no evidence of recurrent veins in the cell of either *aurorina* or *polita;* in the cell of both *piera* and *hypæsia* there are faint traces of three recurrent veins extending from the base to the discocellulars, two of these end in the vicinity of the weak angle of the LDC the other on the R_s near the end of the cell. At the base of the wing there is evidence of a recurrent vein looping back from the A. This is fully developed in *piera* and only partially so in the others, being least well developed in *hypæsia.* A true costal vein is present in *piera.* It is free from the SC throughout. It extends almost to the end of the cell. There is a short costal vein in *hypæsia* and possibly one following the costal margin of the SC for a short distance in *polita.* No trace of such vein is present in *aurorina.* The basal portions of the wings of the four species are figured as is the cell of *hypæsia.*

HINDWINGS. The classical character for separating *Cithærias* (*aurorina* and *polita*) from *Hætera* (*piera* and *hypæsia*) is found on these wings. In the latter "genus" the M_3 and Cu_1 are connate, in the former their origins are well separated. The faintest traces of three recurrent veins are present in the cells of all four.

These veins are most marked in *hypæsia.* Most descriptions of the two genera, *Cithærias* and *Hætera,* mention what Schatz and Roeber call a precostal cell. In all four groups this is present. It is formed by the SC and Rs which are free at the base. The SC bows away from the Rs and again approaches it near the costal margin. In *aurorina, polita* and *piera* the two veins are joined by a very short cross vein, probably R_1. In *hypæsia* there is evidence of this cross vein in the form of a few small plates of chitin. The humeral vein is present in *piera,* represented by a slight chitinization in *hypæsia* and totally absent in *aurorina* and *polita.* The basal portions of the wings of the four species and the cell of *hypæsia* are figured.

THE HEAD: ANTENNÆ. None of the four has a strongly developed club on the antenna. It is best developed on *piera* and least well developed on *polita* (see figures). The antennæ segments number 45 on *aurorina,* 53 on *polita,* 44 on *piera* and 48 on *hypæsia.*

EYES: The eyes are glabrous on all four species.

TONGUE: The tongue of *polita* is noticeably shorter than that of the other three.

PALPI: There is some slight variation in the palpi. In general though they are the same. The distal segment is the shortest and the middle segment the longest (see figures).

PROPORTIONAL LENGTHS OF THE SEGMENTS OF THE PALPI

	Basal	Middle	Distal	Relative length
aurorina	0.22	0.68	0.09	1.00
polita	0.22	0.64	0.14	0.92
piera	0.22	0.60	0.17	0.82
hypæsia	0.24	0.63	0.13	0.86

THORAX: TEGULA. The tegulæ of *aurora, polita* and *piera* are very much alike. That of *hypæsia* is heavier and differently shaped (see figures).

PROTHORACIC LEGS. In both sexes the prothoracic legs are atrophied. In the males the tarsus consists of a single joint. In the females the tarsus is made up of five parts. The proportional lengths of the parts of these legs is presented in the following table.

MALES

	Femur	Tibia	Tarsus	Relative length
aurorina ...	0.34	0.36	0.30	1.00
polita	0.36	0.42	0.22	0.75
piera	0.41	0.43	0.16	0.98
hypæsia	0.36	0.36	0.28	0.95

FEMALES

	Femur	Tibia	Tarsus	Relative length	♂ = 1.00
aurorina ...	0.41	0.31	0.28	1.00	1.33
polita	0.43	0.30	0.27	1.12	2.00
piera	0.41	0.30	0.29	1.32	1.79
hypæsia ...	0.41	0.32	0.27	1.07	1.50

In every instance the proximal tarsal joint in the female is greater than 50 per cent of the total length of the tarsus; *aurorina* 0.60, *polita* 0.62, *piera* 0.64, *hypæsia* 0.61. The sequence of the lengths of the joint is the same in all four species. In descending order they rank 1, 2, 5, 3, 4. Thus the joint next to the distal is the smallest in every case.

MALE GENITALIA: UNCUS. Except in *piera* and its congenors this structure is simple, long and slender. In *piera* it is short, stocky and deeply bifurcate.

TEGUMEN: Shows no characters of generic value.

VINCULUM: Shows no characters of generic value.

SACCUS: Very long in *piera*, moderately long in *aurorina* and its strictest congenors, very short in *polita, menander* and *hypæsia*.

VALVES: These parts are highly variable and form an excellent basis for specific determination but are not of value for generic separation.

ÆDÆAGUS: The *piera* group may be instantly recognized by the large size and curiously curved character of this structure. The rest of the species divides into two groups identical with the division based on the saccus. The *aurorina* group has an ædæagus that is long and tapers from a broad proximal portion. The organ in *polita, menander* and *hypæsia* is short and more or less uniform in its diameter throughout.

In recapitulation it seems to me that in the four groups we have three genera—*Cithærias* is represented above by *aurorina* which is strictly congeneric with the genotype *pireta; Hætera* is repre-

sented by its genotype *piera;* and *hypæsia* which throughout the structural discussion has been seen to differ from *piera* to an incompatible degree. For this species I am proposing a new generic name. I believe that *polita* had best remain in *Cithærias* for the present. It is by no means a true congenor of *pireta* but it is linked to the red winged *Cithærias* through *menander* on a structural basis. If I favored subgenera I would not hesitate to erect one for it, but I don't.

CITHÆRIAS HÜBNER

[1819]. Verz. bek. Schmett., 53.

Type: *pireta* Cramer = *andromeda* Huebner nec Fabricius (1775).

Synonyms: *Callitæra* Butler, Cat. Sat. B. M., p. 101, 1868.
Hetaira Bates, Nat. River Amazon, Clodd ed., p. 52, 1892.
Cythærias Weymer, Stübel's Reise, Lepid., p. 53, 1890.

The validity of the name for this genus is a little involved. In 1807 Fabricius erected the genus *Hætera* for a group of hyaline winged butterflies (Illiger's Magazine, 6: 284, 1807). This genus was not homogeneous, in fact it contained material drawn from both the *Satyridæ* and *Ithomidæ*. Two species were mentioned, *piera* a satyrid and *diaphanus*[1] an ithomid; in addition the author noted that there were sixteen other species to be included. In [1819] Huebner erected the genus *Cithærias* for *piera, cissa, andromeda* and *nereis* (Verz. bek. Schm., p. 53). He also included *philis* and *pireta* Cramer as synonyms of *cissa* and *andromeda* respectively. In the light of modern taxonomy this genus too is not homogeneous but all of the species are *Satyridæ* and are closely related.

In the first really serious attempt to organize the genera of butterflies (Doubleday, Westwood & Hewitson, Gen. Diurn. Lep.) is found an interesting treatment of these insects. As genus IX of the *Satyridæ* Westwood lumped together as *Hætera* the species now recognized as five different genera. Westwood made two divisions of his encompassing genus: Divisions A and B. Of these all of the species with hyaline wings were included under

[1] Genotype of *Hymenitis* Huebner (Scudder).

the first section of division A. This section is noted "Section 1. Wings hyaline (*Hætera* proper, *Cithærias* Hübner)." It in turn is divided into two subsections, a, and b. Subsection a. contains only *piera* Linnæus, one of the species in the original list of species in *Hætera*. Subsection b. contains *andromeda* and *esmeralda*. This action has been interpreted by Butler and later by Godman and Salvin, and Weymer as indicative of synonymizing *Hætera* and *Cithærias* by Westwood. With this I cannot agree. Two genera are synonymous only if they have the same type species or if their type species are congeneric in the strictest sense. In fact no genus is valid unless it is monotypical in its original description, or has had a type designated for it selected from the series of species included in the original description or list of species included within the original genus. Westwood designated no types for these generic terms.

In 1868 Butler (Ent. Mo. Mag., 4: 195, 1868) noted under his second division of the *Satyridæ* "Genus 3. *Gen. Nov.* allied to *Hætera*" and in a footnote to this "This genus includes *esmeralda* and *aurora* groups." Later in that year in the Cat. Sat. B. M., p. 101, he named this genus *Callitæra* and included *menander, aurora, esmeralda, harpalyce* and *andromeda,* but failed to designate a type for the genus. However, on the following page, 102, he does fix the type of *Hætera* as *piera* Linnæus. This is the earliest genotype fixation in the group of genera included under *Hætera* by Westwood.

In 1874, Scudder (Proc. Amer. Acad. Arts and Sci., 10, 1874) pointed out that *Callitæra* (p. 131) is synonymous with *Cithærias* (p. 143) and designated *andromeda* as the genotype of the latter genus but fixed no type for the former. This validates *Cithærias* from 1874 for use with the species herein included.

In using *andromeda* "Fabricius" as the genotype it must be realized that that species is somewhat obscure. Fabricius' original description distinctly indicates that the name was to be applied to one of the forms with blue on the hindwings. (Syst. Ent., p. 467, no. 107, 1775). That he decidedly confused things by writing an amended description twenty-two years later (Ent. Syst., 3: 184, n. 569, 1793) does not alter this. This interpretation of the facts allows only one conclusion, that *esmeralda* Doubleday (Ann. Mag. Nat. Hist., 16: 306, 1845) is a synonym

of *andromeda* Fabricius (Syst. Ent., 467, no. 107, 1775). That the amended description includes what is now known as *menander* Drury (Ill. Ex. Ent., 3: pl. 38, f. 3, 1782) is quite probable and so in part *andromeda* Fabricius (Ent. Syst., 3: 184, no. 569, 1793) is a synonym of *menander*. Since Scudder (*l.c.*) cited *andromeda* Fab. as the type of Huebner's genus *Cithærias* it is important to know which of these two interpretations was placed upon the name by Huebner. In the Verz. bek. Schmett., p. 53, Huebner places *pireta* Cramer as a synonym of *andromeda* Fabricius. Although he cites the 1775 reference to the Fabrician name, it is obvious that he had in mind the rose flushed species as figured by Cramer. Thus Scudder's designation of *andromeda* "Fabricius" as interpreted by Huebner as the genotype of *Cithærias* actually is the designation of *pireta* Cramer for that position.

This change in the name of the genotype may seem contrary to Opinion 65 of the International Commission on Zoological Nomenclature and may indeed need their action. I do not think that they can decide other than I have. However, I have presented the problem to them for final decision.

I have been unable to discover any fixation of type for *Callitæra* Butler. In order definitely to relegate *Callitæra* Butler to the synonymy of *Cithærias* I now designate *aurora* Felder, a species listed by Butler in the original group of species called *Callitæra,* as its genotype. This species is the one most closely allied to *pireta* Cramer included in Butler's list of species for *Callitæra.*

Five forms of the genus fly in Ecuador, two are found on the Pacific slope in the Colombian Pacific division of the humid tropics and three in the eastern Andean foothills of the humid subtropics and the Amazonian jungle.

There are three red marked *Cithærias* found in Ecuador. On the west coast the Central American species *menander* Drury is abundant. In the tropical forest at the foot of the Cordillera Oriental *aurora* Felder and Weymer's *aurorina* are found. Since Weymer seems to have been a little confused about these red forms when he wrote the account of the genus in Seitz' (5: 174–175) perhaps it would be well to set down my own conclusions at this time. Apparently there are two red marked "species" that fly in the Amazon basin. They can be separated by the dark

transverse lines on the hindwing. One of them has the middle line, the limbal line, nearer to the discal line than to the submarginal line. The earliest name that is clearly available for this "species" is *pireta* Cramer. (Pap. Exot., pl. CCCLXX, fig. E.). Weymer's figures of "*pireta*" in Seitz' (5: pl. 42a, 3rd & 4th figures) represent *aurora* Felder which is the earliest name clearly available for the "species" with equidistant lines on the hindwing. The number of dark transverse lines is not constant, however *pireta* usually shows only one while *aurora* and its forms usually show at least traces of two.

Fassl's *rubina* is a synonym of *pireta* Cramer. Fassl created his synonym by following Weymer's diagnosis of *pireta* which unfortunately is incorrect. It is fairly obvious from Weymer's discussion of *pireta* and *aurora* plus his figure of "*pireta*" and *aurorina* in Seitz that his "*pireta*" and *aurora* are synonymous. This led Fassl to re-name the "species" from the southern lower Amazon basin *rubina*. If he had waited until he had Cramer's volumes to consult instead of sending his description in from the field he would not have made this error. Cramer's figure clearly shows the red scaling restricted to the area between M_3 and Cu_2 as on *rubina*.

I have seen Fassl's *phantoma* (Ent. Zeit., Frankfurt, 36: 22, 1922) and it seems to be merely a very pale or faintly colored *aurora*.

The following table presents the differences and similarities of the four pink *Cithærias* found in the Amazon Basin.

	pireta	*aurora*	*aurorina*	*phantoma*
No. transverse lines on forewing	Usually one, rarely two	Usually at least a trace of second	Two	Usually at least a trace of second
Limbal line on h.w. nearer basal than submarginal	Yes	No	No	No
Red scale not reaching cell	Usually just touches cell occasionally not	Always short of cell	Always nearly to base of wing	Rarely beyond limbal line
Color of red scales	Rose-red	Plum	Rose-red	Rose-red
Male genitalia: distal process	Heavy, curved, occasionally hooked*	Heavy, curved	Light,* curved	Heavy, curved

Male genitalia: valve fold	Present	Present	Present	Present
Male genitalia: subscaphium	Present	Present	Present	Present
Male genitalia: tapered aedaeagus	Yes	Yes	Yes	Yes
Male genitalia: uncus/tegumen	1:1	1:1	1:1	1:1
Range	So. of Amazon & Marañon	N., N. W., & W. Amazon drainage	W. Amazon drainage	S. W. Amazon drainage

* The figures of *aurorina* (B1626) and *pireta* (B1703) show this difference in the valves.

Characters in common (range omitted):

	pi.	au.	aa.	ph.
pireta	×			
aurora	5	×		
aurorina	5	6	×	
phantoma	6	8	7	×

Thus it may be seen that *pireta* differs a little more from *aurora* and *aurorina* than from *phantoma* but that *phantoma* is closer to *aurora* and *aurorina* than to *pireta*. On the basis of pattern *pireta* stands alone; on the basis of color, *aurora;* on the basis of genitalia, *aurorina*. But none of these characters are really sufficient in view of the other species in the genus to be considered of specific value in any real sense. I feel that they are all forms of one biological species with a tendency to respond to its environment with slight morphological changes.

It has been suggested by Fassl (*l.c.*) and others that there is but one or at most two species among the colored *Cithærias*. Fassl suggests *menander* and *philis*. On the basis of genitalia *menander* (B1625) is immediately recognizable by the small size of the organs—all of the drawings presented are made to the same scale. Although there are many points of difference in the other species the most obvious and convenient for comparison are those found in the valves. Figures are presented for *philis* (B1711), *polita* (B1708) and *pyropina* (B1662) in addition to *menander, aurorina* and *pireta* noted above.

The problem of the blue *Cithærias* must await more material. I have seen no males of *andromeda* Fabr. (*esmeralda* Doubleday). All of the specimens that have passed through my hands have

been females. This is also true of *pellucida* Butler which I believe is a female form of *philis* Cramer. Butler in a footnote to his description of *harpalyce* (~~T. Ent.~~ Soc. Lond., 1866, p. 42) Proc. Zool. states that *harpalyce* may be the other sex of *pellucida* which he described on the preceding page. Female specimens of *pellucida* and *philis* in the U.S.N.M. are remarkably alike except for the blue-violet scaling on *philis*. The two "species" were taken at the same locality.

C. menander Drury

1782. Ill. Exot. Ent., 3: pl. 38.

Synonym: *andromeda* Fabr. (in part), Ent. Syst., 3: 184, 1793.

Range: Nicaragua southward to western Ecuador.

Ecuador: Balzapamba, Bolivar, 630 m., 17 ♂♂ May–June '38 (W.C.-M.).[2] Playas de Juan Montalva, Los Rios, 30 m., 1 ♂ May '38 (W.C.-M.). Santo Domingo de los Colorados, Pichincha, 500 m., 4 ♂♂ Dec., Jan., Feb. '40–'41 (D.B.L.). La Lorena, Pichincha, 550 m., 3 ♂♂ Feb. '41 (D.B.L.). Rio Toachi, Pichincha, 800 m., 1 ♂ Nov. '39 (W.C.-M.). Palmar, Manabí, 200 m., 1 ♂ 6.v.41 (D.B.L.). Huigra (Rhoads, A.N.S.P.). Dos Puentes (Coxey, A.N.S.P.) "Cuenca" 4 ♂♂, 1 ♀ (R.P.M.). "Loja" 1 ♂ (R.P.M.).

These specimens differ a little from the Central American *menander*. The transverse brownish bar across the hindwing from M_3 to the anal angle is not quite so straight. However, this line is not so broad nor does it stagger as in *aurora* Felder. Another point of variance is the presence of a small white spot in the M_2–M_3 interspace. This seems to be absent in true *menander*. In *aurora* this spot and one in M_3–Cu_1 are present. Several of the specimens, one from La Lorena, one from Rio Toachi, and four from Balzapamba are inseparable from typical *menander*. Thus I am led to believe that the form under discussion is a slight variant of *menander*.

[2] The initials in brackets are of collectors of material in the Brown Collection, F.M.B. = Hazel H. & F. Martin Brown, J.E.S. = J. E. Schilling, W.C.-M. = William Clarke-Macintyre, D.B.L. = David B. Laddey; and of Museums from which I borrowed material, A.M.N.H. = American Museum of Natural History, A.N.S.P. = Academy of Natural Sciences, Philadelphia, R.P.M. = Reading (Pa.) Public Museum, U.S.N.M. = United States National Museum. A full description of the localities mentioned will be found in the Annals of the Entomological Society of America, Dec. 1941.

Drury's figure is of a female.

The male genitalia are smaller than those of *aurora* and show minor differences which may be seen by reference to the drawings.

This species is represented by material from Central America (as far north as Eden, Nicaragua (A.N.S.P.)) in the Academy of Natural Sciences, the American Museum of Natural History, the Reading Public Museum and the U. S. National Museum. In the Reading Public Museum are 19 specimens from various localities in Colombia, all on the west and north slope, and 11 from the Amazon Basin—6 ♂♂ Pebas, Peru, 3 ♂♂ Huaylas, Peru[3] and 2 ♂♂ Sao Gabriel, Upper Amazon, Brazil. These Amazonian specimens are the only ones that I have seen from the region. They are typical *menander* in pattern and genitalia. Since there is no pass in the northern Andes low enough for the passage of the species and since it has not been taken, to my knowledge, along the Orinoco I cannot see how the species entered this upper Amazon Basin. Because of this I question the validity of these Amazonas records. There is other questionable material of this genus in the same collection, specimens of *C. philis* ticketed Medina, Colombia and Chanchamayo, Peru.

The Ecuadorian specimens in the Reading Public Museum are from Mengel's collection and without much doubt were collected by Feyer. They certainly never came from Cuenca and Loja—two highland arid basins. Feyer's localities are notoriously inaccurate. The specimens were probably taken around Dos Puentes or Huigra where Feyer probably collected while enroute from his home in Guayaquil to Cuenca and Loja.

C. pireta f. *aurora* Felder

1862. Wien. Ent. Mon., 6: 175.

Synonyms: *pireta* Weymer nec Cramer, Stübel's Reise, p. 53, 1890.

pireta Weymer nec Cramer, Seitz' 5: pl. 42, line a, figs. 3, 4.

Type locality: Colombia.

Range: northern part of the Amazon Basin and Andean foothills of Venezuela, Colombia, Ecuador and northern Peru.

[3] There is a west slope town of the same name (Huaylas or Huailas) inland from Chimbote but it is too high for *Cithærias* (ca. 2700 m.).

Ecuador: Huagra-yacu, Napo-Pastaza, 900 m., 1 ♂ 31.iii.41 (W.C.-M.). Rio Arajuna, Napo-Pastaza, 1000 m., 2 ♂♂, 1 ♀ 26.iv.–1.v.41 (W.C.-M.). "Riobamba," 1 ♂, 1 ♀ (R.P.M.).

These four specimens from Macintyre come from the heart of the territory occupied by form *aurorina*. They are so distinctive that he thought he had a new species. The female approaches *pyropina* in coloration but the dark areas on the hindwing are not so deep violet, they are nearer to a light plum color. Apparently the stronghold of *aurora* lies in the northwestern part of the Amazon basin but specimens of it are found as far south as NE Peru. The Bassler collection in the American Museum of Natural History contains a specimen from the Rio Abujao, a southern tributary of the Marañon, that may be a female of *aurora* or *aurorina*, I cannot tell. It is much lighter than my Arajuno female and yet it seems too dark to be a typical *aurorina* female. Without males from the region I prefer to consider it *aurorina*. There are three Peruvian specimens in the Reading Public Museum from Pebas, Huaylas and Sana. The "Riobamba" pair noted above in the Reading Public Museum were probably purchased by Mengel from Feyer. The specimens must have come from the central west Oriente and certainly not from Riobamba, an arid, temperate station.

C. pireta f. *aurorina* Weymer

1910. Seitz' Macrolepidoptera, 5: 174; pl. 42, line a.

Synonyms: *aurora* Staudinger nec Felder.
andromeda Dognin nec Fabr. Lep. Loja, p. 8, 1887.
andromeda Dognin nec Fabr. Lep. Loja, p. 33, 1891.

Range: Upper Amazon as far west as the Andean foothills in Colombia, Ecuador, Peru and Bolivia.

Ecuador: Puyo, Napo-Pastaza, 1000 m., 7 ♂♂, 1 ♀ Dec. 1938 (F.M.B.). Rio Jondachi, Napo-Pastaza, 800 m., 3 ♂♂, 1 ♀ Nov. '39 (W.C.-M.). Sucua, Santiago-Zamora, 900 m., 2 ♂♂ 5.ii.39 (F.M.B.). Huagra-yacu, Napo-Pastaza, 900 m., 3 ♂♂, 3 ♀♀ 22.iii–4.iv.41 (W.C.-M.). Rio Arajuna, Napo-Pastaza, 1000 m., 2 ♂♂, 2 ♀♀ 24–30.iv.41 (W.C.-M.). Rio Jollin, nr. Archidona, Napo-Pastaza, 600 m., 1 ♂ 15.vii.41 (W.C.-M.). Sarayacu, Napo-Pastaza, 500 m., 2 ♂♂ vii.39 (Henderson). Macas (Santiago-

Zamora, 1050 m.) 1 ♂, 1 ♀ (R.P.M.). La Merced, below Baños, Rio Pastaza (Coxey, A.N.S.P.). Rio Pupuyacu (Macintyre, A.N.S.P.).

This is the predominant form of *pireta* south of Putamayo. It ranges into eastern Bolivia in the foothills. Males may easily be distinguished from those of *aurora* by the great extent of the rosy flush on the hindwings which almost reaches the base of the cell in *aurorina* and does not reach the cell in *aurora*. The color differs too. On *aurora* it is lilac pink, on *aurorina* rose pink. The females are equally easy to recognize. The limbal transverse line on the hindwings of *aurorina* is brownish while on *aurora* that portion caudad of M_3 is plum colored. South of the Amazon and the Marañon there are occasional specimens on which the pink scaling is greatly reduced. This is f. *phantoma* Fassl. The figure of the male genitalia (1626) is the extreme form found in the "species." Many specimens show almost the same valve structure as in *pireta* (1703).

C. pyropina Godman & Salvin

1868. Ann. Mag. N. H., (4)2: 141.

Type locality: Eastern Peru.

Range: Northeastern Peru and Southeastern Ecuador.

Ecuador: Macas (Santiago-Zamora, 1050 m.) 1 ♂ Jan. 1926 (R.P.M.).

This is the only Ecuadorian specimen known to me. It was probably collected by Feyer or the Olsens and sent to Mengel in whose collection it stands at the Reading Public Museum.

C. polita Hewitson

1869. Trans. Ent. Soc. London., 1869: 34.

Synonym: *Hippomene* Boisduval 1870.

Type locality: Chontales, Nicaragua.

Range: Nicaragua south to western Ecuador.

Ecuador: Santo Domingos de los Colorados, Pichincha, 500 m., 2 ♂♂, 2 ♀♀ Dec.–Mch. '40–'41 (D.B.L.). La Lorena, Pichincha, 550 m., 2 ♂♂, 3 ♀♀ Feb. '41 (D.B.L.). Palmar, Manabí, 200 m., 1 ♂, 2 ♀♀ Mch.–May '41 (D.B.L.).

Godman and Salvin give only the Central American range and knew of the species only from Nicaragua and Panama. Weymer

added Colombia and now Laddey has turned up the species in western Ecuador. It is improbable that its range will be extended further south. It does not seem to be so rare in Ecuador as elsewhere. It is interesting to note that in western Colombia the closely related species *mimica* Rosenberg & Talbot (T. E. S. Lond., 1913, p. 677) interrupts the continuity of the range of *polita* Hewitson. It is possible that Weymer's Colombian specimens represent *mimica* R & T. The pattern and wing form of this species is quite distinct from all others in the genus. This difference is borne out in the form of the genitalia of the males (B1708) and in many minor structural items. When the life histories are known for this group of insects it may be required that *polita* and *mimica* be divorced from *Cithærias.*

Boisduval in his "Considérations sur les Lépidoptérés envoyés du Guatemala á M. de l'Orza," 1870, on page 62 states: "Hætera Hypæsia, Hewits. *Hippomene,* Bd. Deux individus de Nicaragua." This reference has been overlooked by Kirby although other species noted in the paper are given in the "Appendix" to his "Catalogue," by Godman and Salvin in the "Biologia" and its "Supplement," and by Gaede in the recent "Lepidopterorum Catalogus 29": *Satyridæ.* Since *hypæsia* does not occur in Central America and the only clear winged satyrid occurring there that might be confused with it is *polita* it is obvious that Boisduval was referring to that species. Thus we have as a synonym of *polita, hippomene* Bdv. I do not consider *hippomene* as a manuscript name or *nomina nuda* since it was published in such fashion that it might be recognized by a student of the group under discussion.

Hætera Fabricius

1807. Illiger's Magazine, 6: 284.
Type: *piera* Linneus (Butler, 1868).
Synonyms: *Oreas* Huebner [1807].
Pselna, Billberg, Enum. Ins., p. 77, 1820.
Hetæra, Butler, Cat. Sat. B. M., p. 101, 1868 (*et al.*).

Oreas was first used by Huebner in the *Tentamen* [1806] and subsequently in the Samml. exot. Schmett., 1, pl. (82) [1807]. Scudder's designation of (*proserpina* =) *circe* as the type does

not hold since Opinion 97, I.C.Z.N., declares the names in the *Tentamen nomina nuda* and therefore the genus *Oreas* must date from its next use. In the *Sammlung* it is used for *piera* which Hemming made its type in 1937. (Proc. R. Ent. Soc. Lond., (B)6: 152–153, 1937.) In the same paper Hemming points out that action taken by the I.C.Z.N., in 1935 considers the Fabrician name to have priority until precise dates regarding both Huebner's work and volume six of Illiger's Magazine are forthcoming. Thus *Oreas* Huebner may in time replace *Hætera* Fabricius.

Hætera piera Linneus

1764. Mus. Ulr. 220.

Synonym: ♀ *anacardii* Fabricius (*nec* Linneus), Syst. Ent., p. 467, no. 105, 1775.

Range: Amazon and Orinoco Basin and the Guianas.

H. piera (L.) is an extremely variable species. It differs from the following, *macleannania* Bates, in several minor respects other than in the form of the male genitalia. The most noticeable of these characteristic differences is the lack of yellow stain on the hindwings of both sexes of *macleannania*. Several names have been applied to various modifications of the basic pattern of *piera*. Those specimens lacking the anterior of the two ocelli are named *unocellata* Weymer. This is the only clear cut form of the species thus far described. There is a female in the collection of the U.S.N.M. collected by Dr. Wm. Mann at Tumupasa, Bolivia, that may be this form. While it does not lack the anterior ocellus that mark is greatly reduced and smaller than the posterior ocellus. The margin of the hindwing does not bear a distinct line but is smudged with brownish scales especially along the veins. The yellow stain on the hindwings of this form is greatly reduced. Weymer notes that the iris of the ocelli on the underside of this form is sulphur-yellow not red-yellow. This is true of the female noted above and also of various *piera*-forms from "Peru" (G. G. MacBean, U.S.N.M.), from Surinam (Wm. Schaus, U.S.N.M.), and several specimens noted from various rivers in eastern Peru (H. Bassler, A.M.N.H., F. Woytkowsky, F.M.B.) so I doubt that this can be used as a critical character.

The insect described as *diaphana* by Lucas in Sagra's "Historia de la Cuba," Lepid., p. 587, 1857, has been designated a form of

piera by Weymer (Seitz' 5: 175, 1911). In 1874 (P.Z.S., p. 337, 1874) Butler and Druce used the term for a male *macleannania* from Costa Rica in Druce's collection. Godman and Salvin (Biologia, Rhop., 1: 66, 1880) object to this on the basis of Lucas' stress upon the lack of red on the outer margin of the secondaries and the less angular outline of these wings when compared with *piera.* These two characters do separate Lucas' form from all of the specimens of *macleannania* that I have seen. Ten years after Lucas, Felder described *hymenœa* (Reise Novara, Lep. Rhop., 459, 1869) from Bahia, Brazil. This has been considered a synonym of *diaphana.* Unfortunately the only male of this insect that I have seen had been "restored" with a strange abdomen and I have not been able to prove or disprove a feeling I have that this is not a form of *piera* but a good species.

Felder described a form of *piera* as *negra* (Wien. Ent. Mon., 6: 176, 1862). This was from the Rio Negro, a northern tributary of the Amazon. The characters by which he set this form apart from *piera* are: ♂, the larger size, the obsolescences of the brown lines on the hindwings, a submarginal line and the total absence of red color from the margin of the hindwing; ♀, much more flexed and indefinite transverse band, the portion between the third median (Cu_2) and the internal vein (A) moved basad. This last statement in regard to the female is in error; the bar that is moved is Cu_1–Cu_2. I have seen this form from the Upper Ucayali, Peru (Bassler, A.M.N.H.), the Maroni River, B.G., and Surinam (Schaus, U.S.N.M.), Cayenne (Johnson, A.M.N.H.), various localities in British Guiana (Beebe, Lutz, etc., A.M.N.H.). Thus it seems to be fairly well distributed through the northern and western range of the species. The ten males that I have seen from the Rio Negro are typical *piera!* There is no difference between the genitalia of *negra* and *piera.* Thus I am led to believe that these two names designate the extremes of variation in typical *piera.* In general those specimens with well developed transverse bars more or less in a uniform line should be designated typical *piera* and those with an irregular obsolescent set of transverse markings, *piera* form *negra.*

Of Ecuadorian specimens Godman and Salvin (*l.c.*) state: "Of the races of *piera* in South America, that found in Ecuador is perhaps the most nearly allied to *H. macleannania,* as in it we find

the greatest development of red about the anal angle of the secondaries of the female. It (*macleannania*) has, however, the clear secondaries in common with the Brazilian *H. hymenœa,* and also the strongly marked band.'' It happens that in Ecuador both a form of *H. macleannania* and a form of *H. piera* are found that agree with the first sentence quoted above. However only the specimens of *macleannania* agree with the second sentence. The *macleannania*-like form of *piera* bears the characteristic yellow stain. This form is found at least as far east as Iquitos, Peru (F. Johnson, U.S.N.M.), as far south as Chanchamayo, Peru (B. P. Clark, U.S.N.M.), as far north as ''Colombia'' (F. Ovalle, A.M.N.H.) and west into the foothills of the Cordillera Oriental as high as Yungilla, Ecuador, 1400 m. (Coxey, A.N.S.P.). Bassler's extended series from the rivers tributary to the Marañon from the south in Peru does not contain this form. However, there is a good series in the Reading Public Museum from Juanguay, farther upstream on the Huallaga than any of Bassler's stations. With the exception of the Iquitos specimen all others come from regions above 500 m.—above the fall line. Thus I am inclined to doubt the veracity of that record. The specimen was probably collected by Klug who I know went far west of Iquitos and well into the zone in which this form flies. Intermediate specimens between it and typical *piera* are not rare in Surinam, Cayenne, British Guiana and the central Amazon basin north of the great river.

A larger series of specimens may prove that the material from north of the Amazon is truly separable from that found to the south. The major portion of the series (102 specimens) that I have before me are from the north and west and from it I can find no good reason for making such a division.

H. piera f. *ecuadora* n. f.

Type locality: Rio Tutenongoza, Sucua, Santiago-Zamora, Ecuador.

Range: Eastern foothills of the Andes from Central Peru to Colombia and eastward to the fall line.

Types: Holotype: a female, Rio Tutenongoza, Sucua, Santiago-Zamora, 850 m., Ecuador, 9.ii.39 (F.M.B.).

Allotype: A male, Puyo, Napo-Pastaza, 1000 m., Ecuador, 7.xii.38 (F.M.B.).

Paratypes: No. 1, a male, same date as Allotype. Nos. 2–6, 2 ♂♂, 3 ♀♀ Rio Jondachi, nr. Archidona, Napo-Pastaza, 800 m., Ecuador (W.C.-M.). No. 7, a male, Canelos, Rio Bobonaza, Napo-Pastaza, 700 m., Ecuador, 13.xii.38 (W.C.-M.). Nos. 8–9, 1 ♂, 1 ♀ Sarayacu, Rio Bobonaza, Napo-Pastaza, ca. 500 m., Ecuador (Coll. Wm. Schaus, U.S.N.M.). Nos. 10–11, 1 ♂, 1 ♀ Macas, Santiago-Zamora, 1050 m., Ecuador (Coll. E. W. Rorer, U.S.N.M.). No. 12, a male, "Ecuador" (Coll. F. Johnson, U.S.N.M.). No. 13, a female, Yungilla nr. Banos, Ecuador, 4000 ft. (Coll. W. J. Coxey ex Feyer, A.N.S.P.). No. 14, a male, La Merced, below Baños, Rio Pastaza, Ecuador, 4000 ft. (W. J. Coxey, A.N.S.P.). No. 15, 1 ♂ Macas, Jan. '26 (Coll. L. Mengel, R.P.M.).

Other specimens: 3 ♂♂ Macas, Jan. '26 (R.P.M.). 1 ♂ "Riobamba" (R.P.M.). 1 ♂ Huagra-yacu, Oriente, 900 m., 21.iii.41 (W.C.-M.). 1 ♂ Sarayacu, Oriente, 500 m., xii.39 (Henderson). 1 ♂ Rio Arajuno, Oriente, 1000 m., 1.v.41 (W.C.-M.).

This race differs from typical *piera* in the females, having the areas between the margin and the brown limbal transverse bars red or reddish-orange between veins A_1-Cu_2, Cu_2-Cu_1 and usually the posterior half of the area Cu_1-M_3 red. Occasionally all of this last area is red. These females differ from those of *macleannania* in having the usual yellow stain of *piera* and in that the red scaling rarely extends basad of the transverse bars but stops at those bars. The transverse bar in interspace Cu_1-Cu_2 is much more basad than the two flanking it on most specimens. This is another difference from typical *piera*. Thus *piera* seems to vary in three definite directions: 1st, toward obsolescence of the brown lines; this is especially noticeable in the males; 2nd, Cu_2–Cu_1 transverse bar on the hindwing migrates basad; 3rd, the development of reddish scales in the vicinity of the anal angle. This leads to eight possible combinations of the extremes:

A.—brown line fully developed; Cu_2-Cu_1 in line; no red.
B.—brown line fully developed; Cu_2-Cu_1 in line; with red.
C.—brown line fully developed; Cu_2-Cu_1 basad; no red.
D.—brown line fully developed; Cu_2-Cu_1 basad; with red.
E.—brown line obsolescent; Cu_2-Cu_1 in line; no red.

F.—brown line obsolescent; Cu_2-Cu_1 in line; with red.

G.—brown line obsolescent; Cu_2-Cu_1 basad; no red.

H.—brown line obsolescent; Cu_2-Cu_1 basad; with red.

Of these, condition A may be said to represent typical female *piera* from the Guianas; B is found in Colombia, Ecuador and Peru among the females; C is common in NE Peru among females taken with typical male *negra;* D is the usual condition in *ecuadora* females; E is found commonly among male *piera* from the Guianas; F I have never seen; G is typical of male *negra* and H is typical of male *ecuadora.* Thus the fully developed transverse brown line on the hindwing appears to be a female character, while the obsolescence of this line is a male character. Less than one per cent of either sex seems to bear the character of the opposite sex. The basad movement of the bar Cu_1-Cu_2 seems to be characteristic of the forms *negra* and *ecuadora.* The presence of this plus red on the margin of the wing may be taken as the key characteristic of *ecuadora.*

There is some variation in the extent of the opaque scaling on the margin of the hindwings of the females; it may be restricted to the A-Cu_2 area or extend from A to M_3.

It will be noted above that combination B is present in females and not in males—to my knowledge—and that it is nameless. To satisfy taxonomists I name this *H. piera ecuadora* female form *pseudopiera.*

H. p. f. *ecuadora* ♀ f. *pseudopiera* n. f.

Type locality: Macas, Santiago-Zamora, Ecuador.

Range: the same as for the parent form *ecuador.*

Type: Holotype, Macas, El Oriente, Ecuador, Jan. '26 (Mengel Coll., R.P.M.).

Paratype: No. 1, La Salud, Chanchamayo, Peru (Mengel Coll., R.P.M.). No. 2, Chiquita River Valley, Colombia (Mengel Coll., R.P.M.). No. 3, same as No. 1 (retained by F.M.B.).

This form differs from the typical in two points: the transverse bars just basad of the anal ocellus are in nearly a straight line and the red scaling is almost entirely restricted to the margin of the wing with only a scattering of scales in the A-M_3 interspaces.

I have seen a number of intermediate specimens but the fully developed form is quite distinctive.

Hœtera macleannania Bates

1865. Ent. Mo. Mag., 1: 180.

Type locality: Lion Hill Station, Canal Zone.

Range: Honduras to central western Ecuador.

H. macleannania laddeya n. r.

Type locality: Hda. La Lorena, nr. Santo Domingo de los Colorados, Pichincha, Ecuador.

Types: Holotype: a male, Hda. La Lorena, nr. Santo Domingo de los Colorados, Pichincha, 550 m., Ecuador, 21.ii.41. (D.B.L.).

Allotype: a female, same locality as holotype, 8.iii.41 (D.B.L.).

Paratypes: Nos. 1–3, 2 ♂♂, 1 ♀ same locality, 25,28,28.ii.41 (D.B.L.).

This race differs from the typical insect in the boldness of its dark markings. The curved, V-shaped limbal band is very dark brown, almost black. It is particularly noticeable on the females. On typical female *macleannania* this dark band is practically absent from M_3 to Cu_2; on *laddeya* it is as heavy in this region as the conspicuous bar between Cu_2 and A_1 on *macleannania.* The difference between *piera* and *macleannania* noted above holds for *laddeya* and sets it apart from *piera ecuadora.* The angle on the hindwing of the males of *laddeya* does not contain so much red as on the males of the older named form and the red is terra cotta, not old rose. There is no valid difference between the male genitalia of *laddeya* (B1709) and *macleannania* from Panama. These organs of the males dispel any notion that the two species, *piera* (B1658) and *macleannania* are one.

This new race is named for its collector, David B. Laddey.

♀ f. *neglecta* n. f.

Types: Holotype: a female, same data as *laddeya,* 25.ii.41 (D.B.L.).

Paratype: a female, same data, 1.iii.41 (D.B.L.).

This interesting form lacks any touch of red on the hindwings and is easily confused with the males of the race. From the males it differs in that the dark markings are broader and the anal ocellus is bracketed above and below with patches of white scales that fill or almost fill the area between the dark markings and the ocellus. There are also diffuse patches of white scales in the basad

portions of the hyaline areas between the dark markings in the two interspaces flanking the anal ocellus.

Pseudohætera n. g.

Type: *Hætera hypæsia* Hewitson.

The markedly different male genitalia of *hypæsia* when compared with true *Hætera* makes it necessary to erect a new genus for this species. The venations of the two genera are essentially alike but in *Hætera* on the hindwing the SC and R_s are joined by a thick cross vein beyond the origin of the H. This connection between the SC and R_s beyond the H is absent in *Pseudohætera.* The wings of *Pseudohætera* are more rounded than those of *Hætera,* especially the hindwings which are quite angular in *Hætera.* The basic pattern of the maculation of *Pseudohætera* is closer to that of *Cithærias* than that of *Hætera.* The points of difference between *Hætera* and *Pseudohætera* have been set forth previously.

The differences between the male genitalia of *Pseudohætera* and *Hætera* are best seen in the drawings *1627* and *1658.* They may be summarized as follows:

Uncus: *Pseudohætera,* long, slender, simple.
Hætera, short, compact, deeply bifurcate.

Tegumen: *Pseudohætera,* deeper than long.
Hætera, longer than deep.

Vinculum: *Pseudohætera,* moderately slender and more or less uniform in width.
Hætera, broad and foliate at ventrum.

Saccus: *Pseudohætera,* short.
Hætera, long.

Valves: *Pseudohætera,* semi-quadrangular, dorsal margin delicate and irregular.
Hætera, semi-triangular, dorsal margin strong and armed.

Ædæagus: *Pseudohætera,* short, stocky, undulant: distal orifice nearly rectangular.
Hætera, long, stocky, proximal half a full reflexed curve 90° in one direction, then over 180° in the opposite direction; distal orifice on a long tangent.

Pseudohœtera hypœsia Hewitson

1854. Trans. Ent. Soc. Lond., ser. 2, 2: 247, pl. 23, f. 2.

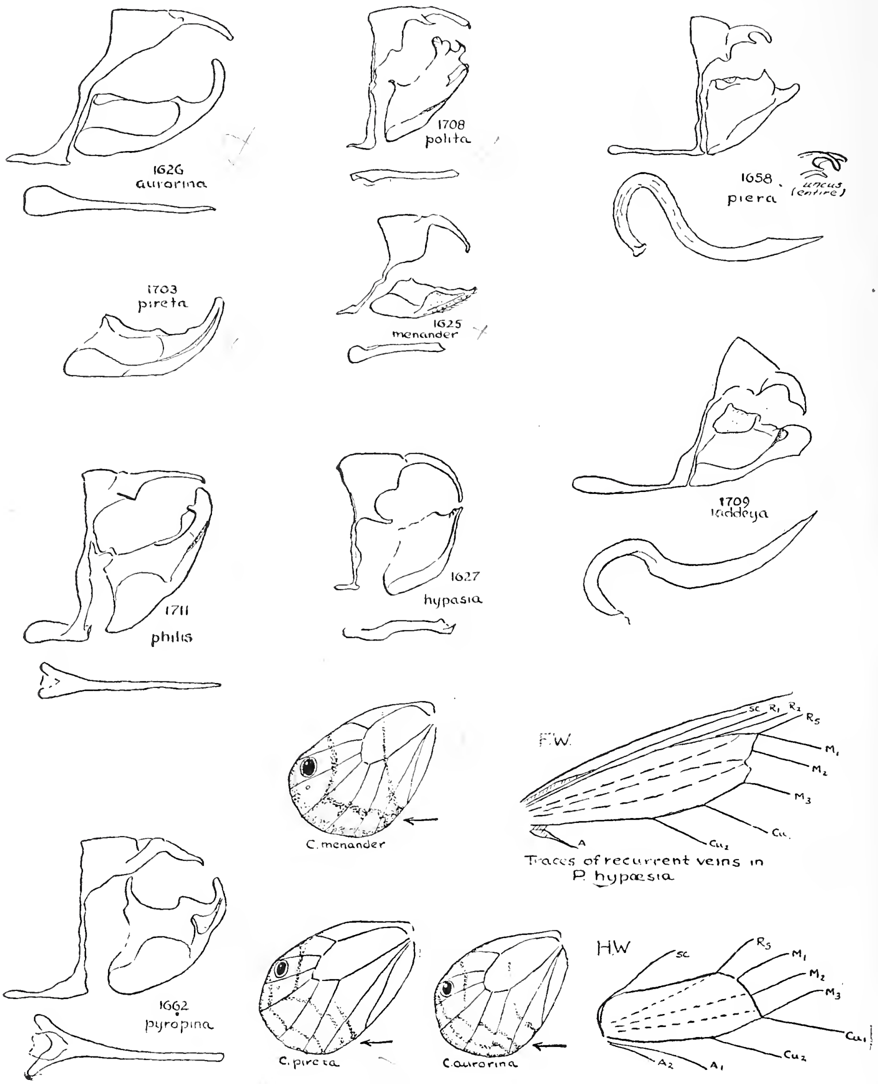
Type locality: Bogota, Colombia.

Range: Colombia to Bolivia in eastern foothills of the Andes and adjacent lowlands.

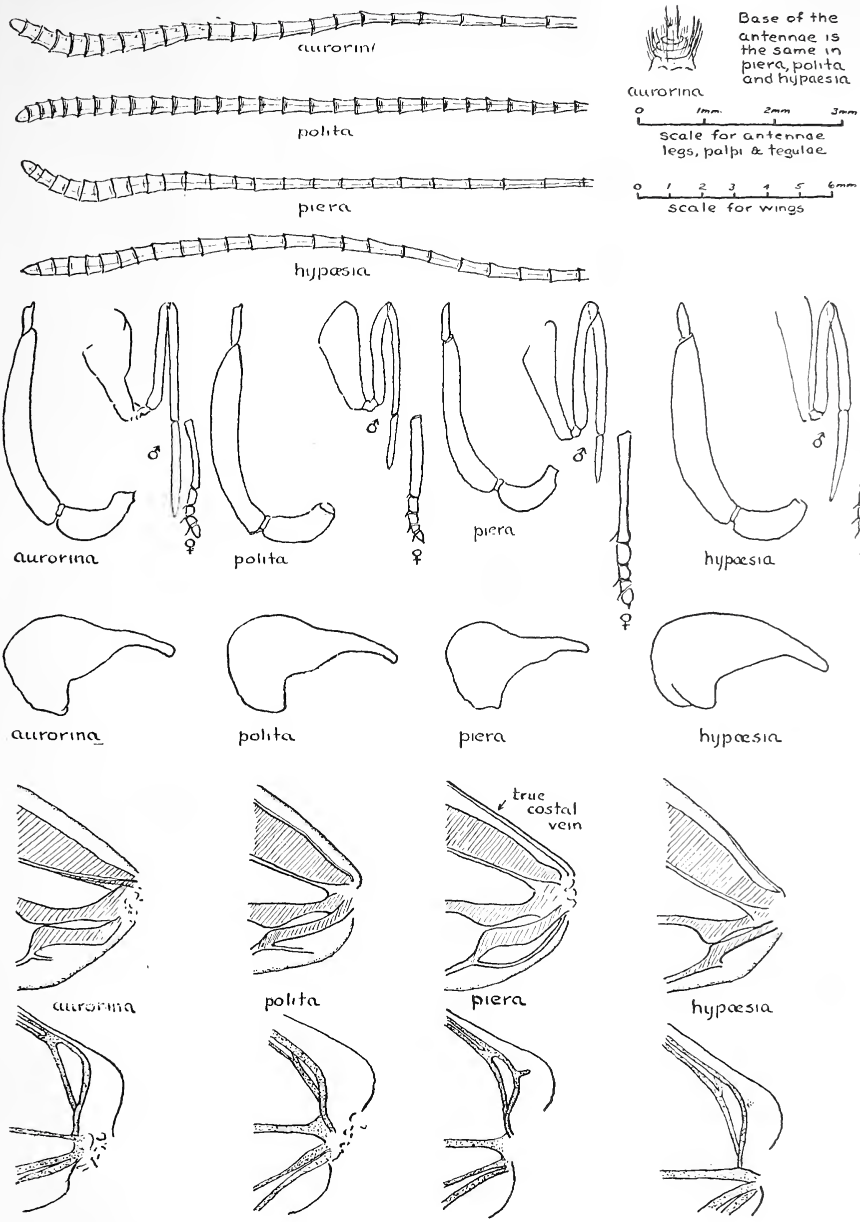
Ecuador: Hda. San Francisco, Tungurahua, 1300–1400 m., 9 ♂♂, 3 ♀♀ ix–39, iii–40 (F.M.B.). Hda. Chinchin Grande, Tungurahua, 1400 m., 1 ♂ x–39 (J.E.S.). Rio Margajitas, Tungurahua, 1250 m., 1 ♂, 1 ♀ ix–39 (F.M.B.). Hda. Sta. Inez, Tungurahua, 1250 m., 1 ♂ 29.ix.39 (F.M.B.). Hda. La Palmera, Tungurahua, 1200 m., 1 ♂, 1 ♀ xii–38 (W.C.-M.). Abitagua, Napo-Pastaza, 1300 m., 2 ♂♂, 1 ♀ v–vi.39 (W.C.-M.). Puyo, Napo-Pastaza, 1000 m., 8 ♂♂, 2 ♀♀ xii–38 (F.M.B.). bet. Macas & Rio Abonica, Santiago-Zamora, 1200 m., 1 ♂ 21.i.39 (F.M.B.). Huagra-yacu, Napo-Pastaza, 900 m., 2 ♀♀ 21.iii–8.v.41 (W.C.-M.). Bombaini-yacu, Napo-Pastaza, 900 m., 1 ♂ (W.C.-M.). "Loja," 2 ♂♂, 1 ♀ (R.P.M.). Macas (Santiago-Zamora, 1050 m.) Jan. '26, 1 ♂ (R.P.M.). Fortaleza, Oriente, 1 ♂ (R.P.M.). La Merced, Rio Pastaza, below Baños (Coxey, A.N.S.P.).

There is some variation in the markings on the underside of the hindwing. Some specimens are marked with black scales, others have a rufous marking bordered with black. There seems to be no relationship between these two forms and either sex or geographic area. I see no need for separate designations.

The "Loja" specimen noted above must have come from somewhere east of that city. Probably along the Rio Zamora or on the trail between Zamora and San Francisco, the pass through the eastern Andes east of Loja. The Fortaleza specimen comes from a region that lies far to the east of the area I have generally considered the range of this species. In the same collection (Reading Public Museum) are specimens from Pebas, Iquitos and Huaylas, all in Amazonian Peru. However, since the extensive Bassler collection made in Amazonian Peru does not contain this species from east of Moyabamba I am inclined to reserve judgment on the validity of the localities on this R.P.M. material.



ECUADORIAN BUTTERFLIES



ECUADORIAN BUTTERFLIES

BOOK NOTICE

Near Horizons, The Story of an Insect Garden. Illustrated with more than 160 Photographs by the Author. By Edwin Way Teale. Dodd, Mead & Company, New York, 1942. $9\frac{3}{4} \times 7$ inches. XVII + 319 p. illus. $3.75.

When Edwin Way Teale stretches out on his ventral surface on the warm sands of Long Island and watches the every-day activities of an ant-lion, poetry and adventure are in the making. In an insect sanctuary of his own making, fifteen minutes from his home, over a period of six years, Mr. Teale at various and numerous time has entered an "insect world," and watched, recorded and photographed the incredible and fantastic doings of its inhabitants.

His adventures, which are now in print under the title "Near Horizons" make fascinating reading and his remarkable photographic illustrations are perfect. Mr. Teale does not achieve his result by endowing insects with human attributes, but by accurate observations, basic scientific knowledge, and a discriminating sense for using words that enable the reader to share his interest and enthusiasm.

Froghoppers, butterfly battles, the insect horizon, insect sleep, rat-tailed maggots, may-flies, ant-lions, wasps, caterpillars, bees, butterflies, lacewings, crane flies, water-striders, katydids and mantids are only a few of the insects, that performed in Mr. Teale's "garden," and whose activities are set forth interspersed with historical viewpoints, allied happenings, and bits of the author's philosophy. Each chapter is an essay in itself, involving the liveliness of different species as related to a central theme.

Entomologists in particular will be pleased to find a whole chapter under the title "Cicada Man," devoted to William T. Davis, and an excellent photograph—both true to life—of a noted naturalist who is admired and respected by all who know him.

Mr. Teale's abilities as a naturalist and as an expert photographer are both evident in this, his latest book, which is worthy of a place in every entomologist's library.—H. B.W.

THE PARASITIC HABITS OF MUSCINA STABULANS FABRICIUS

By C. H. Curran

Over a period of many years specimens of *Muscina stabulans* Fabricius have been received with the notation that they were parasitic on certain insects but as most material was reared in cages containing soil there seemed to be reason to believe that the records were in error. Evidence now available indicates that the species is definitely parasitic and that it has a wide variety of habits. I do not recall the circumstances surrounding most of the rearings that have come to my notice but some of the observations made are worthy of mention.

In 1941 Mr. Henry Bird submitted a series of specimens he had reared in Rye, New York. He informed me that he had found the larvæ attacking the pupæ of the elm leaf beetle in areas about the base of the tree where the pupæ were numerous. The fly larvæ were not internal parasites but were predaceous upon the beetle pupæ. There has been considerable other evidence to substantiate the predaceous habits of the *Muscina* larvæ.

As concerns the internal parasitic habit I cite the following incident. Some time in early June my young son gathered about a dozen wandering caterpillars of the American tent caterpillar and placed them in a jar. The top of the jar was tightly screwed on so there was no opportunity for the flies to lay eggs. The jar was set aside and received very little attention but eventually a moth was observed in the jar and in late June (1942) my son stated that there were some flies in the jar. It was then decided to clean out the jar but it remained in its undisturbed state, as such things are liable to, for a time longer. On July 4th my son informed me there were more flies in the jar and he brought it to me. A number of flies were crawling about actively but I paid little attention to them, presuming that they were one of the well-known parasites. Eventually (July 9) the jar was opened and the flies examined. All proved to be *Muscina stabulans*.

Since the original object had been to raise some moths no count was made of the number of caterpillars. They had been picked

up while crawling on the sidewalks in the northern part of Manhattan, New York City. The number was roughly a dozen, certainly not more than fifteen. From these caterpillars only two moths emerged. Twenty-eight adult flies were taken from the jar and counted but there were a number, perhaps as many as ten, that were left tangled in the cocoons. This indicates that more than one larva was present in at least most of the caterpillars.

Admittedly this is not a very scientific experiment, but it does prove to my satisfaction that *Muscina stabulans* is at times parasitic. Since it is not very scientific we may be excused if we speculate upon the method by which the fly larvæ enter the caterpillars. The "tents" provide an excellent place for the deposition of eggs and if they are laid in the tents, which the flies could easily enter through the openings the caterpillars use, it would be easy for the larvæ to attack the caterpillars and bore their way inside. This appears to be the most logical method, but the eggs might also be laid on the silken "runways" the caterpillars build in going and coming from the "tent."

It seems likely that the larvæ of *Muscina stabulans* are normally predaceous and that they are not scavengers, as has been generally believed. Possibly their association with the house fly and other insect larvæ is due to their predaceous habits. The internal parasitic habit does not appear to be well established because records are not numerous. We may therefore assume that it is internally parasitic incidentally or accidentally; only when circumstances are most favorable.

Previous records, that I recall, of the parasitic habit, are from South Africa, Canada and the United States. I believe that the Canadian records included sawflies and grasshoppers, as well as other insects.

It is hoped that with the definite establishment of the parasitic habit of *stabulans* further studies may be made in order to learn the true facts about this insect. As it is a very common species it possibly plays an important part in the natural control of insects. If certain strains should prove to be parasitically inclined it is possible that they would be of value in the control of certain types of pests that occur in large enough numbers to cause serious damage.

INDEX TO NAMES OF INSECTS AND PLANTS IN VOLUME L

Generic names begin with capital letters. New genera, subgenera, species, subspecies, varieties and new names are printed in italics.

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